CHAPTER III. ENVIRONMENTAL SETTING

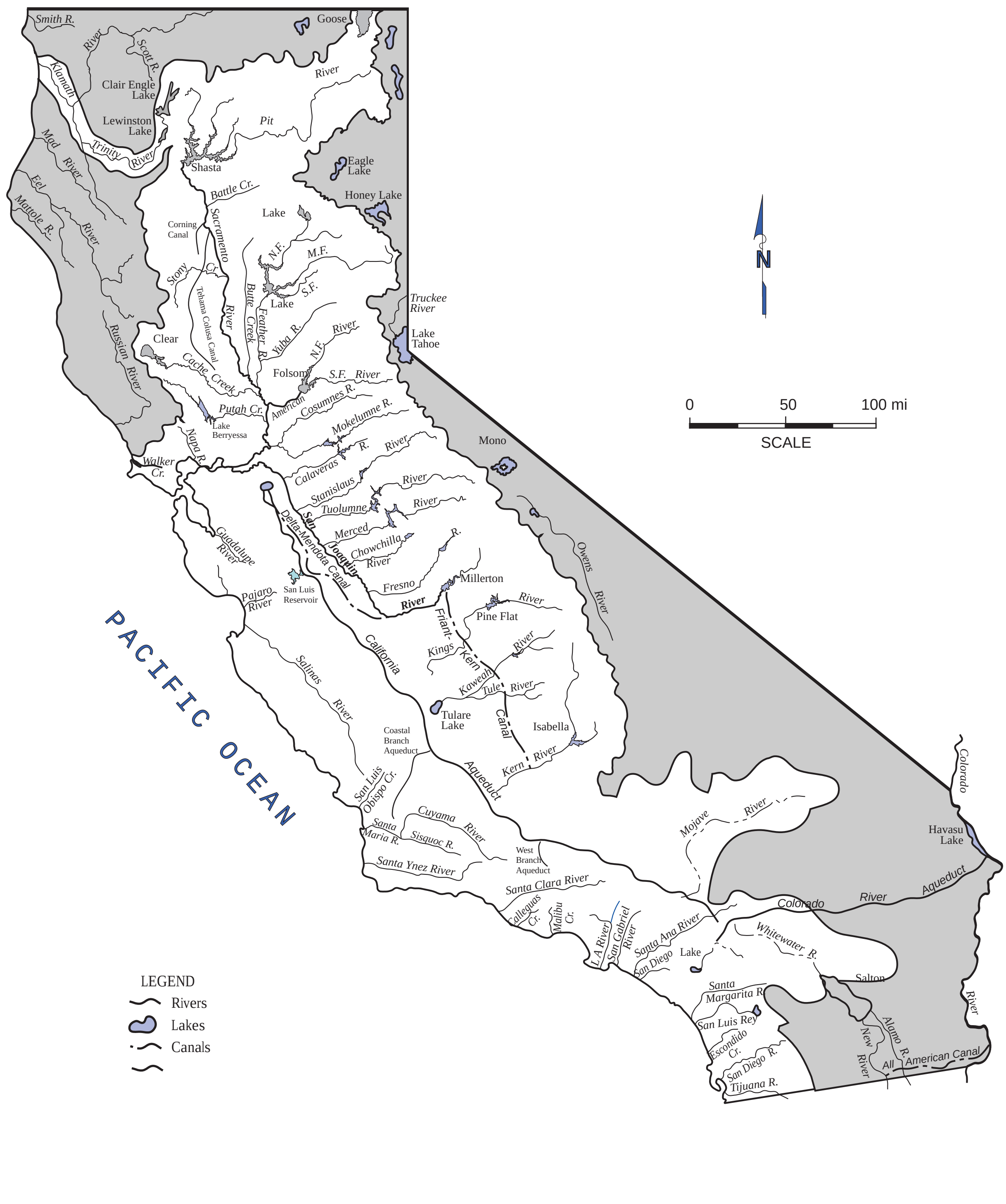
This chapter describes the environmental setting of the proposed project. The environmental setting is defined as the physical conditions that exist within the area which will be affected either directly or indirectly by the proposed project. (Public Resources Code section 15360). The purpose of the Environmental Setting chapter is to provide a baseline of the existing environmental conditions by which to determine the environmental impacts of the proposed action. The environmental setting for this project was described in Chapter IV of the ER (SWRCB 1995). The discussion here details the upstream areas and updates the discussion in Chapter IV of the ER.

Due to the significant interdependence of water supplies and uses in California, implementing the objectives for the Bay/Delta Estuary is relevant not only to the Estuary itself but also to a large portion of the State. The effects of the SWRCB's water right decision may be seen in the areas that are the source of the water for the Bay/Delta Estuary, as well as in the service areas to where water from the Central Valley is exported. The source areas include the Trinity River Basin, Sacramento River Basin, San Joaquin River Basin, the Sacramento-San Joaquin Delta, and Suisun Marsh. The export areas include the San Francisco Bay Region, the portion of the San Joaquin River Basin served by the Delta-Mendota Canal, the Tulare Lake Basin, Central Coast Region, and the portion of Southern California served by the State Water Project. The project area is shown in Figure III-1.

The discussion of the environmental setting is organized essentially by the major hydrologic regions as defined in DWR Bulletin 160-93, The California Water Plan Update (DWR 1994). The Trinity River Basin is part of the North Coast Region; however, it is unlikely that any effects of the SWRCB decision will be seen in the North Coast Region outside of the Trinity River Basin. The project area in Southern California includes the South Coast Region, as well as the Antelope Valley and Mojave areas of the South Lahontan Region and the Coachella area of the Colorado River Region. These areas were combined to represent the SWP Southern California service area.

The factors used to describe the existing environmental conditions in the affected areas include: geography and climate, population, land use and economy, water supply (including hydrology and water quality), water use, vegetation, fish, wildlife, and recreation. The source of much of the information on geography and climate, population, land use and economy, water supply, and water use is DWR Bulletin 160-93. Much of the information on hydrology, water quality, vegetation, fish, and wildlife is taken from the State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR 1996). The discussion of surface water development draws from Bulletin 160-93 (DWR 1994) and the Central Valley Project Improvement Act, Draft Programmatic Environmental Impact Statement, Technical Appendix, Volume 2, Surface Water Supplies and Facilities Operations (USBR 1997a). Information on recreation in the Sacramento River, San Joaquin River, and Tulare Lake regions comes from

Figure III-1
Map of Affected Area
(shaded area excluded)



the Central Valley Project Improvement Act, Draft Programmatic Environmental Impact Statement, Technical Appendix, Volume 4, Recreation (USBR 1997b). The discussion of aquatic resources is based in large part on the Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes (USFWS 1996).

This chapter begins with an overview of the Central Valley, including the development of surface water supplies, and the aquatic resources and recreational opportunities found therein. The Central Valley overview includes a discussion of the physical components of the Central Valley Project (CVP), State Water Project (SWP), and local water supply projects. Detailed descriptions of several anadromous fish and other special-status species found in the Bay/Delta Estuary and tributary streams are also presented in the overview.

A. CENTRAL VALLEY BASIN OVERVIEW

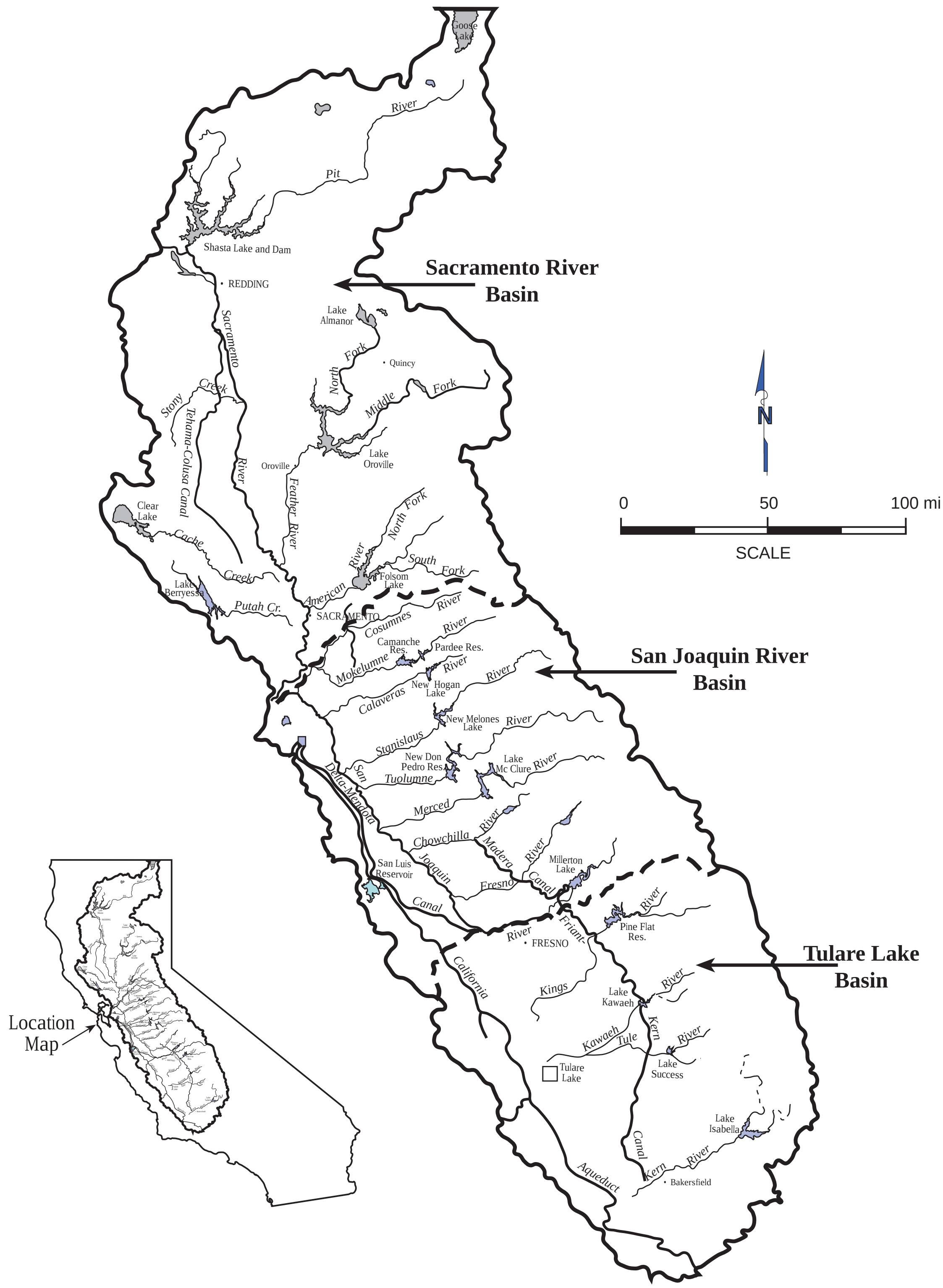
The Central Valley basin of California (Figure III-2) is comprised of the 450-mile long Central Valley and the surrounding upland and mountain areas which drain into it. The basin encompasses about 60,000 square miles and makes up about 40 percent of California. The basin is entirely surrounded by mountains except for a narrow gap on the western edge at the Carquinez Strait.

Stream flow in the Central Valley is chiefly derived from runoff from the Cascade and Sierra Nevada mountains, with minor amounts from the Coast Ranges. Precipitation totals vary annually with about four-fifths of the total occurring between the last of October and the first of April. Snow storage in the high Sierra delays the runoff from that area until the snow melts in April, May, and June. Normally, half of the annual runoff occurs in these months.

The Central Valley basin is divided into the Sacramento Valley on the north and the San Joaquin Valley on the south. The Sacramento Valley is part of the Sacramento River Basin. The San Joaquin Valley spans two sub-basins: the San Joaquin River Basin and the Tulare Lake Basin. These two basins are distinct drainage areas separated by a low divide formed by coalescing alluvial fans. The divide lies between the San Joaquin River to the north and Kings River to the south. Because the rivers and streams in the Tulare Lake Basin do not normally contribute runoff to the Delta, the environmental setting of the Tulare Lake Basin will be discussed as a separate region. The area in the center of the Central Valley where the Sacramento and San Joaquin valleys merge coincides with a break in the coastal mountains which border the basin on the west side. Here the Sacramento and San Joaquin rivers converge in the Bay/Delta Estuary, flow through Suisun Bay and Carquinez Strait into San Francisco Bay, and out the Golden Gate to the Pacific Ocean.

Water is used in the Central Valley basin primarily for growing crops. Water is used to a lesser extent to meet urban, industrial, environmental, and instream needs, and for other uses. Local irrigation districts, municipal utility districts, county agencies, private companies or corporations, and State and federal agencies have developed surface water supply projects. Flood control, water

Figure III-2
Central Valley Basin



storage, and diversion works exist on all major streams in the basin, altering the natural flow patterns. These projects also produce hydroelectric power, enhance recreation opportunities, and serve other purposes. The major surface water supply developments will be discussed in the following sections.

Groundwater is also used extensively in the Central Valley. The regional aquifer system beneath the Central Valley is contained in semi-consolidated to unconsolidated marine and continental deposits. Fresh water in these deposits extends to about 1,100 feet below land surface in the Sacramento Valley and to about 1,500 feet below land surface in the San Joaquin Valley. The storage capacity of the Central Valley regional aquifer system has been estimated by DWR to be 64 million acre-feet and the perennial yield to be 5.7 million acre-feet. Overdraft conditions exist throughout much of the aquifer system in the San Joaquin Valley. In the Sacramento Valley, overdraft conditions are limited to a few localized areas.

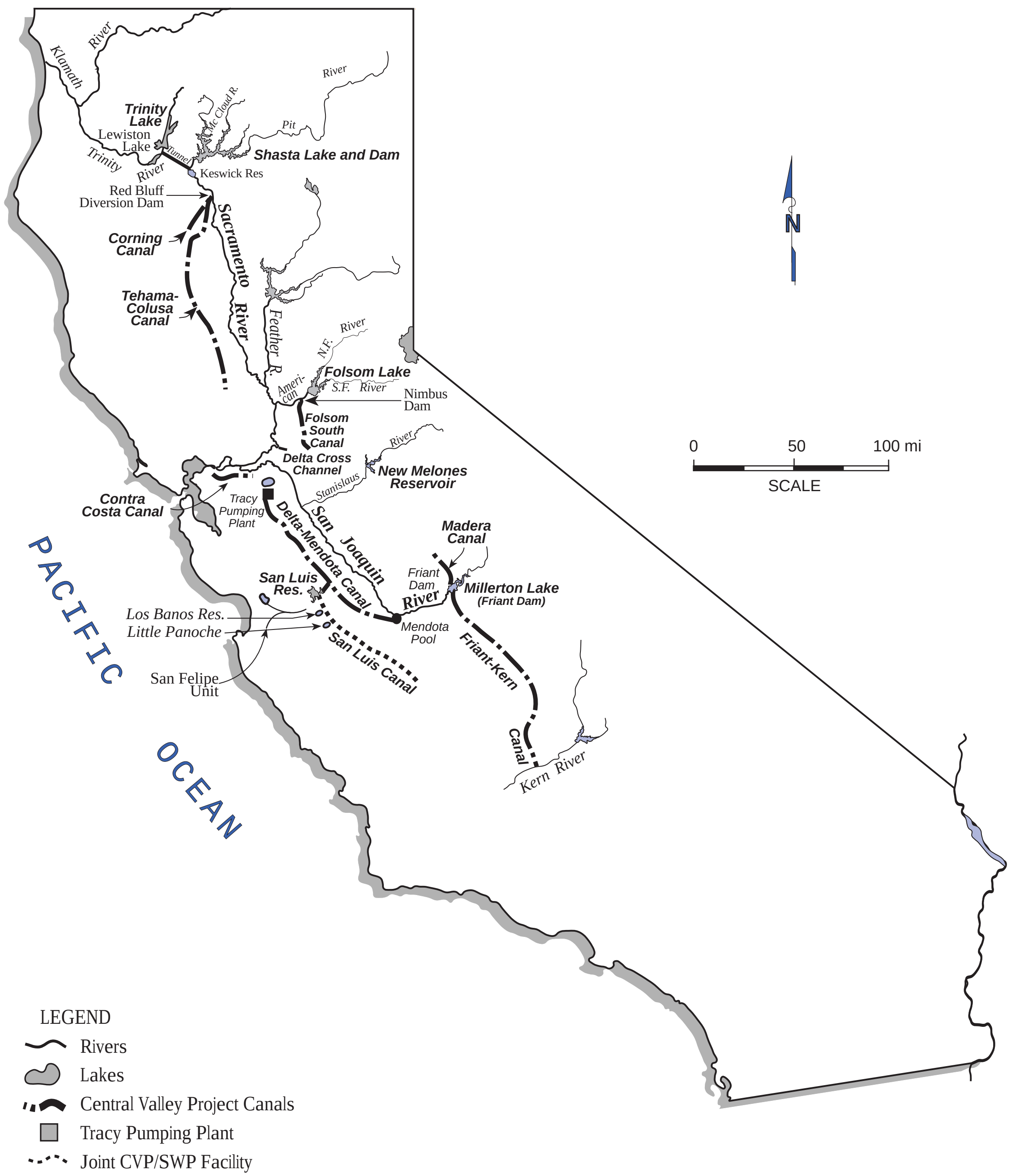
1. Surface Water Development

This section discusses the development of the surface water supplies of the Central Valley. The major developments include the CVP, other federal projects, the SWP, and several local projects.

a. Central Valley Project. The CVP is a water supply, flood control and power generation project owned by the United States and operated by the USBR. It is the largest water storage and delivery system in California. Extending from the Cascade Range to the Kern River, the CVP consists of 18 federal reservoirs, plus four additional reservoirs jointly owned with the SWP. It also includes eight hydroelectric plants, two pumping plants, two pump-generating plants, and about 500 miles of major canals and aqueducts. The project stores and controls waters of the Sacramento, Trinity, American, San Joaquin, and Stanislaus river basins. The major features of the CVP are shown in Figure III-3.

The CVP has three main storage facilities in northern California. The principal facility is Shasta Dam and the 4.5 MAF Lake Shasta on the Sacramento River near Redding. Water from the Trinity River, which drains to the Pacific Ocean, is imported into the Central Valley through tunnels connecting to the Sacramento River north of Redding. Trinity Lake is the largest storage facility in the Trinity River Division. Folsom Dam is located on the American River about 30 river miles upstream from its confluence with the Sacramento River. These main reservoirs of the CVP have a total storage capacity of about 8 MAF. The major storage facilities south of the Delta include New Melones Reservoir on the Stanislaus River, Millerton Lake on the San Joaquin River, and San Luis Reservoir. San Luis Reservoir is a pumped-storage reservoir on the west side of the San Joaquin Valley shared with the SWP. The storage facilities south of the Delta provide an additional 4 MAF storage capacity for the CVP.

Figure III-3
Central Valley Project Facilities



A number of conveyance and pumping facilities are used to distribute water throughout the CVP service area. The major conveyance facilities of the CVP include the Corning and Tehama-Colusa canals which divert water from the Sacramento River to serve the west side of the Sacramento Valley, the Contra Costa and Delta-Mendota canals which divert water from the Delta, the San Luis Canal which carries water along the west side of the San Joaquin Valley, and the Madera and Friant-Kern canals that divert water from the San Joaquin River and distribute it along the east side of the San Joaquin Valley and Tulare Lake Basin. Tracy Pumping Plant pumps most of the water that the CVP exports from the Delta.

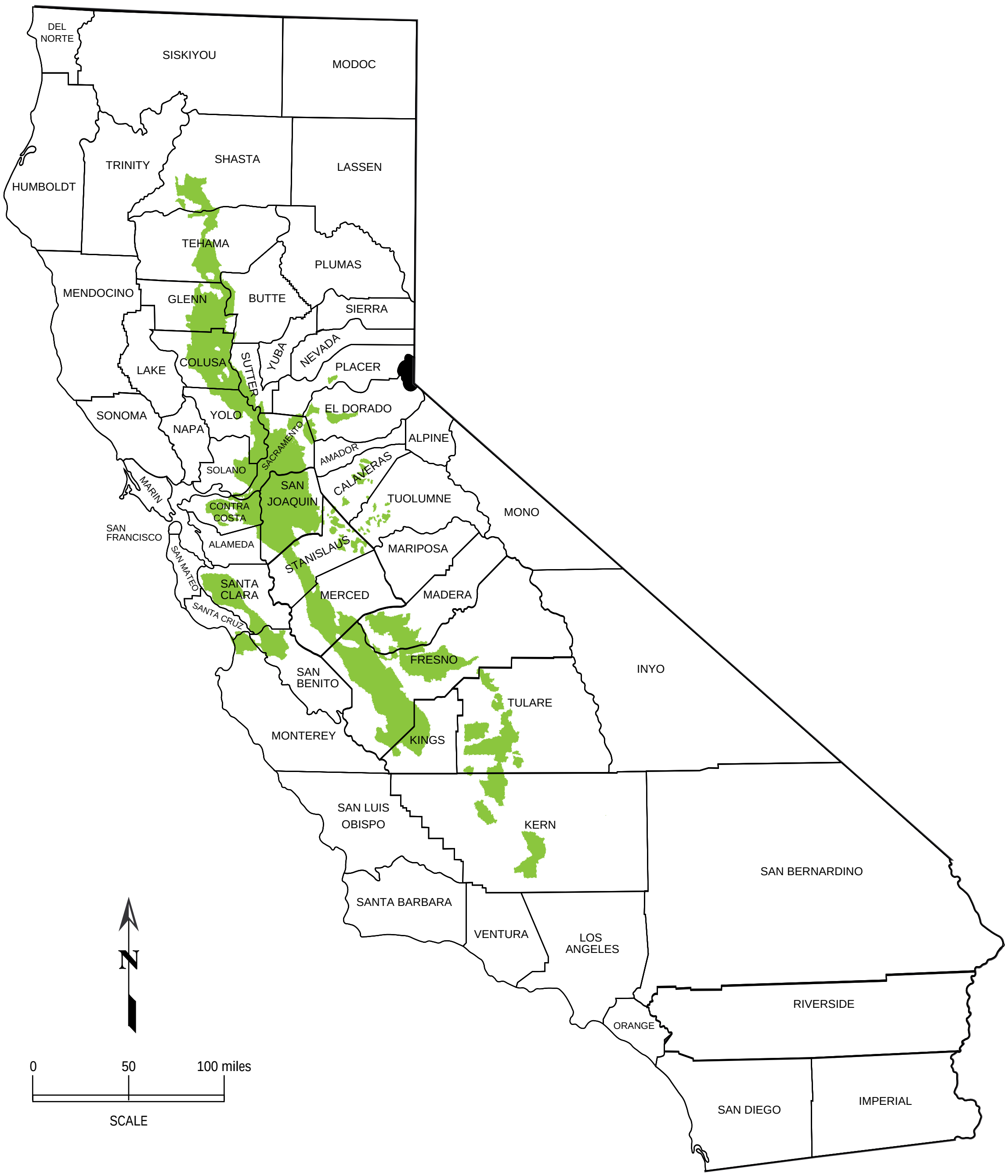
The CVP supplies water to over 250 long-term water contractors whose contracts total 9.3 MAF per year. Of the 9.3 MAF, 6.2 MAF is project water, including 1.4 MAF of Friant Division Class 2 supply in wet years, and 3.1 MAF is water right settlement water. Water right settlement water is diverted by water right holders whose diversions were in existence before the project was constructed. The diversions are made in accordance with agreements between the CVP and the water right holders. Average-year deliveries by the CVP have been around 7 MAF. Figure III-4 shows the CVP contractors' service areas. Figure III-5 shows CVP deliveries for the period 1960-1996.

About 90 percent of the CVP water has gone to agricultural uses in the recent past; this includes water delivered to prior right holders. CVP water is used to irrigate some 19,000 farms covering 3 million acres. Currently, increasing quantities of water are being served to municipal customers. Urban areas receiving CVP water supply include Redding, Sacramento, Folsom, Tracy, most of Santa Clara County, northeastern Contra Costa County, Stockton, and Fresno.

Water stored in CVP northern reservoirs is gradually released down the Sacramento River, where it helps meet contract commitments along the river and quality and flow requirements in the Delta. The remainder is exported via the Contra Costa Canal and the Delta-Mendota Canal. Excess water during the winter is conveyed to off-stream storage in San Luis Reservoir on the west side of the San Joaquin Valley for subsequent delivery to the San Luis and San Felipe units.

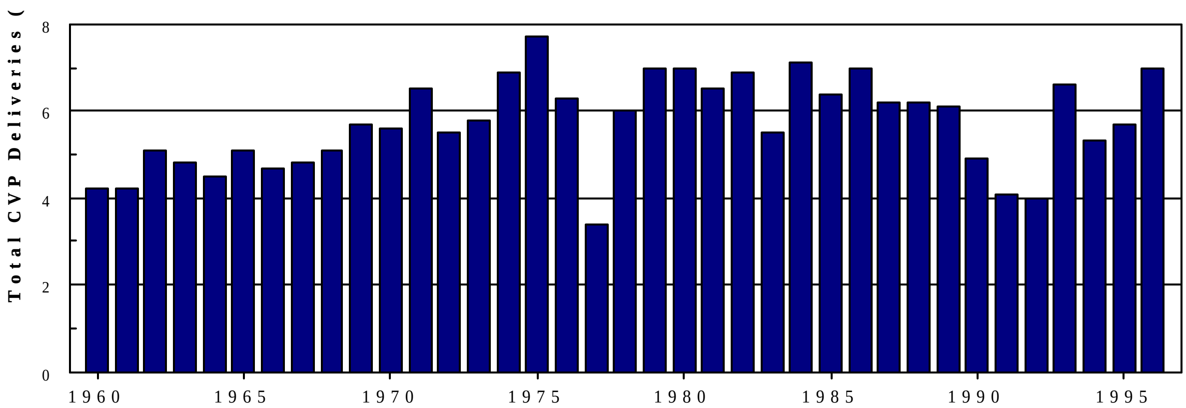
Many of the CVP contractors in the Sacramento Valley held prior rights to the waters of the Sacramento River. Since construction of the CVP altered the natural flows upon which water right holders had relied, contracts were negotiated to serve the users stored water to supplement the river flows available under their water rights. CVP contractors with prior water rights on the Sacramento River (called *settlement contractors*) receive their supply from natural flow, storage regulated at Shasta Dam, and Trinity Basin imports. Table III-1 shows base entitlement, project entitlement, and average deliveries from the main stem of the Sacramento River for some of the largest CVP contractors in the Sacramento Valley. The Tehama-Colusa and Corning canals serve an area on the west side of the Sacramento Valley. Table III-2 shows project entitlement and average deliveries for CVP contractors served by the Tehama-Colusa and Corning canals.

Figure III-4
Central Valley Project Service Area



Source: DWR, Bulletin 160-93 (1994)

Figure III-5
Central Valley Project Deliveries, 1960 to 1996



(Millions of acre-feet)

Table III-1. CVP Deliveries to Selected Settlement Contractors
(Acre-feet)

Contractor	River Mile	Total Base Entitlement	Total Project Entitlement	Average* Deliveries
Glen Colusa I.D.	154.8 R	720,000	105,000	775,418
Sutter Mutual Water Co.	32.4 L	172,900	95,000	205,377
Anderson Cottonwood I.D.	240.5 L	165,000	10,000	144,955
Reclamation District #108	43.1 R	199,000	33,000	136,384
Natomas Central Mutual Water Co.	2.15 L	98,200	22,000	89,376
Reclamation District #1004	85.3 L	56,400	15,000	63,849
Princeton-Codora-Glen I.D.	112.3 R	52,810	15,000	54,942
Provident I.D.	124.2 R	49,730	5,000	39,064
Conaway Conservancy	112.0 R	50,190	672	29,481
Olive Percy Davis Trust	77.8 R	22,000	9,800	26,636
Meridian Farms Water Co.	71.1 L	23,000	12,000	25,777
River Garden Farms Co.	34.5 R	29,300	500	18,900
Pleasant Grove-Verona MWC	19.6 L	23,790	2,500	14,186
Colusa Drain MWC**	NA	0	100,000	12,517
City of Redding	246.0 L	6,889	1,216	10,721
Total, Fifteen Major Contractors				1,647,584
Total, 124 Other Settlement Contractors				91,291
Majors as % of Grand Total				94.75%

*Period of record for determining average deliveries is 1982-1989, excluding 1983.

**Colusa Drain MWC has an exchange contract with the CVP which enables them to divert water from the Colusa Basin Drain. The CVP makes up the impact of that diversion to downstream senior water right holders. No water is delivered directly to CDMWC by the CVP.

Table III- 2. CVP Deliveries to Tehama-Colusa Canal Contractors
(Acre-feet)

Contractor	Total Project Entitlement	Average* Deliveries
Orland-Artois Water District	53,000	70,529
Colusa County Water District	62,000	44,404
Kanawha Water District	45,000	38,000
Westside Water District	25,000	25,481
Corning Water District	25,300	24,521
Glide Water District	10,500	13,083
Dunnigan Water District	19,000	11,965
Westside Water Dist. (from Colusa Co.)	40,000	8,604
Thomes Creek Water District	8,400	7,295
Proberta Water District	5,500	5,630
Davis Water District	4,000	5,310
La Grande Water District	5,000	5,136
4-M Water District (from Colusa Co.)	5,700	2,814
Holthouse Water District (from Colusa Co.)	2,450	1,999
Cortina Water District (from Colusa Co.)	1,700	1,645
Colusa Co. Water Dist (from Colusa Co.)	5,965	1,572
La Grande Water Dist. (from Colusa Co.)	2,200	1,433
Glenn Valley Water District	1,730	879
Kirkwood Water District	2,100	495
Myers-Marsh MWC (from Colusa Co.)	255	438
Total		271,235

*Period of record for determining average deliveries is 1982-1989, excluding 1983.

Settlement contractors on the San Joaquin River (called *exchange contractors*) receive Delta water via the Delta-Mendota Canal. A portion of the water exported from the Delta via the Delta-Mendota Canal is placed into the San Joaquin River at Mendota Pool to serve, by exchange, water users who have riparian and pre-1914 rights to use of San Joaquin River flow. The exchange agreement has annual and monthly limitations on the water to be provided by the USBR to the exchange contractors and the annual amount to be provided is based on forecasted runoff into Shasta Reservoir. This exchange enabled the CVP to build Friant Dam on the San Joaquin River, northeast of Fresno, and divert a major portion of the flow from the river at that point. Most of the water from the upper San Joaquin River is diverted south into the Friant-Kern Canal and supplied to the Tulare Lake Basin for use in Kings and Kern counties. A portion is diverted northward in the Madera Canal to serve areas in the central San Joaquin Valley. Table III-3 lists the CVP exchange contractors and their average annual diversions.

Table III-3. CVP Exchange Contractors Average Annual Diversions
(Acre-feet)

Contractor	Average Diversion
Central California Irrigation District	430,600
San Luis Canal Company	155,600
Firebaugh Canal Water District	64,200
Columbia Canal Company	58,800

CVP facilities are grouped as operating divisions and the operation of these facilities are integrated to enable flexibility in the distribution of water and power resources throughout the project service area. The CVP divisions include the Trinity River, Shasta, Sacramento River, American River, Delta, West San Joaquin, San Felipe, East Side, and Friant divisions.

Trinity River Division. The Trinity River Division was completed in 1964 and includes facilities to store and regulate flows in the Trinity River and to transfer a portion of the flow to the Sacramento River Basin. These facilities include Trinity Lake; Trinity Dam and Powerplant; Lewiston Dam, Lake, and Powerplant; Clear Creek Tunnel and Carr Powerplant; Whiskeytown Dam and Lake; Spring Creek Debris Dam, Reservoir, Powerplant, and Tunnel.

Water is stored in Trinity Lake behind Trinity Dam, and is released for a variety of purposes. Releases from Trinity Lake are re-regulated downstream at Lewiston Lake. Lewiston Dam regulates flows in the Trinity River to meet downstream flow, in-basin diversion, and temperature requirements. Lewiston Lake provides a forebay for interbasin transfer of water through the Clear Creek Tunnel and the Judge Francis Carr Powerplant into Whiskeytown Lake on Clear Creek. Water stored in Whiskeytown Lake includes exports from the Trinity River as well as local runoff from the Clear Creek drainage area. Releases from Whiskeytown are either passed through the Spring Creek Powerplant and discharged into Keswick Reservoir on the Sacramento River, or released to Clear Creek to meet downstream flow and diversion requirements.

Shasta Division. The Shasta Division consists of Shasta Lake, Dam, and Powerplant and Keswick Reservoir, Dam, and Powerplant. These facilities are located on the Sacramento River below the confluence of the Sacramento, McCloud, and Pit rivers. Shasta Dam was completed in 1945 and regulates a drainage area of 6,600 square miles. It provides flood control and stores water for irrigation and M&I use, generation of hydroelectricity, maintenance of fish and navigation flows, and protection of the Delta from salinity intrusion. A small amount of water is diverted directly from Shasta Lake for M&I use by local communities.

Water in Shasta Lake is released through or around Shasta Powerplant to Keswick Reservoir. A temperature control device was recently installed on Shasta Dam which was designed to allow all releases at Shasta to pass through generation facilities when the system is being operated to meet a temperature standard for fishery enhancement/protection on the upper Sacramento River. A series of gates on the intake structure allows for the withdrawal of water at various lake levels.

Keswick Reservoir serves as an afterbay to regulate releases from Shasta Dam and discharges from Spring Creek Tunnel. All releases from Keswick are made to the Sacramento River. There is a migratory fish trapping facility at Keswick that operates in conjunction with the Coleman National Fish Hatchery located downstream on Battle Creek.

Sacramento River Division. The Sacramento River Division includes the Sacramento Canals Unit which was authorized in 1950 to supply irrigation water to over 200,000 acres in the Sacramento Valley, principally in Tehama, Glenn, Colusa, and Yolo counties. The Sacramento Canals Unit consists of the Red Bluff Diversion Dam, the Corning Pumping Plant, and the Corning and Tehama-Colusa canals. The Red Bluff Diversion Dam, built in 1964, is located on the Sacramento River southeast of the town of Red Bluff. Water is diverted from the Sacramento River into the Tehama-Colusa Canal, which extends southerly from the Red Bluff Diversion Dam, to provide irrigation service on the west side of the Sacramento Valley. The Tehama-Colusa Canal also provides water to the refuges under contract with the USBR. The Corning Pumping Plant lifts water from the Tehama-Colusa Canal downstream of the Red Bluff Diversion Dam into the Corning Canal. The Corning Canal provides service to areas on the west side of the Sacramento Valley at elevations too high to be served by the Tehama-Colusa Canal. Congressional authorization has been given (CVPIA, Title 34, Section 3412) to extend the Tehama-Colusa Canal into Solano and Napa counties.

American River Division. The American River Division includes Folsom Dam, Lake, and Powerplant; Lake Natoma; and Nimbus Dam and Powerplant on the American River. It also includes the Folsom South Canal, which diverts water from the American River, and Jenkinson Lake on Sly Park Creek, which is tributary to the Cosumnes River. Folsom Dam, which was completed in 1956, regulates flows on the American River for irrigation, power, flood control, M&I use, fish and wildlife, recreation, and other purposes. Lake Natoma regulates the releases from Folsom Powerplant and Nimbus Dam serves as the point of diversion for the Folsom South Canal. The Nimbus Fish Hatchery is located below Nimbus Dam and was built to compensate for the salmon and steelhead spawning areas lost due to the construction of Folsom and Nimbus dams.

Delta Division. Water released from the CVP reservoirs in northern California is conveyed to the Bay/Delta Estuary through the channel of the Sacramento River. The Delta Division facilities provide for the transport of water through the Delta and the export of water to the San Joaquin Valley and Contra Costa County. The main features of the Delta Division are the Delta Cross Channel, the Contra Costa Canal, Tracy Pumping Plant, and the Delta-Mendota Canal.

About 30 miles south of Sacramento, the Delta Cross Channel diverts a portion of the Sacramento River flow into interior Delta channels, while the remaining Sacramento River water flows westward toward Suisun Bay. The purpose of the Delta Cross Channel is to preserve the quality of water diverted from the Sacramento River by conveying it to southern Delta pumping plants through eastern Delta channels rather than allowing it to flow through more saline western Delta channels. The Delta Cross Channel, with a capacity of 3,500 cfs, can divert a significant portion of the Sacramento River flows, particularly in the fall.

In the southern Delta, the CVP diverts water at Rock Slough, Old River, and at the Tracy Pumping Plant. The Rock Slough diversion is conveyed through the Contra Costa Canal for municipal and industrial uses in Contra Costa County. The Old River intake, near the Highway 4 crossing, was completed in 1997 and diverts CVP water either directly to the Contra Costa Water District (CCWD) service area or into storage at CCWD's new Los Vaqueros Reservoir. At the Tracy Pumping Plant, water is lifted nearly 200 feet above sea level into the Delta-Mendota Canal.

The Delta-Mendota Canal serves several purposes; it delivers water to San Joaquin River water rights holders through exchange agreements, supplies water for agricultural users on the west side of the San Joaquin Valley, and conveys water for storage in San Luis Reservoir. As its name indicates, the canal conveys water from the Delta 117 miles southeast to the Mendota Pool located on the San Joaquin River west of Fresno. West of Los Banos, a turnout from the Delta-Mendota Canal conveys water to the CVP's San Luis Unit.

West San Joaquin Division. The West San Joaquin Division of the CVP includes the San Luis Unit and consists of federal as well as joint federal-State facilities, including O'Neill Dam and Forebay, San Luis Dam and Reservoir, and San Luis Canal. San Luis Reservoir is a pumped-storage reservoir primarily used to store water exported from the Delta by the SWP and CVP.

O'Neill Forebay is used as a hydraulic junction point for State and federal waters. The SWP California Aqueduct discharges directly into the forebay and CVP water is lifted from the Delta-Mendota Canal into the forebay by the O'Neill Pumping-Generating Plant. Water is pumped from O'Neill Forebay into San Luis Reservoir through the William R. Giannelli Pumping-Generating Plant. The forebay provides re-regulation storage necessary to permit off-peak pumping and on-peak power generation by the plant. Power is also generated when CVP water is released from O'Neill Forebay to the Delta-Mendota Canal.

The portion of water stored by the CVP in San Luis Reservoir is released to three locations: the San Luis Canal to serve CVP contractors, including Westlands WD; the Pacheco Tunnel to serve the San Felipe Unit of the CVP; and the Delta-Mendota Canal to serve CVP and exchange contractors on the west side of the San Joaquin Valley. The San Luis Canal conveys water southward from O'Neill Forebay along the west side of the San Joaquin Valley. The San Luis Canal is the joint federal and State portion of the California Aqueduct, extending to Kettleman City. CVP water conveyed through the Delta-Mendota Canal is released into the San Joaquin River channel at the Mendota Pool to replace the exchange contractors' entitlements which are diverted at Friant Dam.

Other facilities included in the West San Joaquin Division include the Coalinga Canal, the Los Banos and Little Panoche detention dams and reservoirs, and the San Luis Drain. The Coalinga Canal transports water from the San Luis Canal to the Coalinga area. The Los Banos and Little Panoche detention dams and reservoirs protect the San Luis Canal by controlling flows of streams crossing the canal. These facilities do not supply water to the CVP or SWP. The San Luis Drain was designed to carry agricultural subsurface drainage from collectors along the west side of the San Joaquin Valley to the Sacramento-San Joaquin Delta for discharge to the ocean, as mandated by the authorization of the San Luis Unit. However, only a portion of the drain was constructed, terminating at Kesterson Reservoir which was incorporated into the Kesterson National Wildlife Refuge. The discovery of accumulations of selenium in the drainage water and sediments at Kesterson Reservoir forced the closure of the reservoir and the drain after 1985. Ongoing actions regarding the San Luis Drain are discussed in Chapter VIII of this draft EIR.

San Felipe Division. The San Felipe Division provides CVP water to Santa Clara and San Benito counties through conveyance facilities from San Luis Reservoir. These facilities include the Pacheco Tunnel and Conduit, the Hollister Conduit, San Justo Dam and Reservoir, and the Santa Clara Conduit. The Pajaro Valley, in southern Santa Cruz County, was originally authorized to receive irrigation water from the CVP to reduce seawater intrusion caused by groundwater pumping, but no conveyance facilities have been built.

Water leaves San Luis Reservoir through the two separate reaches of the Pacheco Tunnel. The water flows through the first reach of the tunnel and is lifted up to the second reach by the Pacheco Pumping Plant. Water from the Pacheco Tunnel flows through the Pacheco Conduit where the flow is split between the Santa Clara and Hollister conduits.

East Side Division. The East Side Division of the CVP includes reservoirs on the Stanislaus, Chowchilla, and Fresno rivers. These rivers drain the western slopes of the Sierra Nevada and flow into the San Joaquin River. The major CVP facilities in the East Side Division include New Melones Dam and Reservoir, Buchanan Dam and Eastman Lake, Hidden Dam and Hensley Lake.

New Melones Dam is located on the Stanislaus River. Originally authorized for flood control in 1944, it was reauthorized in 1962 as an integral part of the CVP and construction was completed in 1979. New Melones is operated to provide flood control, satisfy water rights obligations, provide instream flows, maintain water quality conditions in the Stanislaus River and the San Joaquin River at Vernalis, and provide deliveries to local CVP contractors.

Buchanan Dam and Eastman Lake are located on the Chowchilla River; Hidden Dam and Hensley Lake are on the Fresno River. These reservoirs are operated largely for flood control, but the operations are integrated into the CVP. When possible, releases from these reservoirs are used to satisfy portions of the CVP contractual requirements on the Madera Canal.

Friant Division. The Friant Division collects water from the San Joaquin River and distributes it along the east side of the San Joaquin Valley and the Tulare Lake Basin to provide a supplemental water supply to augment the groundwater and local surface water supplies in the area. The division is an integral part of the CVP, but is hydrologically independent and, therefore operated separately from the other divisions of the CVP. The water supply to the Friant Division is made available in part through an exchange agreement and from purchase of water rights. A substitute water supply for the Exchange Contractors is transported from the Delta to Mendota Pool via the Delta-Mendota Canal. The functions of the Friant Division are to provide flood control, irrigation, and M&I water supply. Major facilities of the division include Friant Dam and Millerton Lake, the Madera Canal, and the Friant-Kern Canal.

Friant Dam is located on the upper San Joaquin River in the Sierra-Nevada foothills above Fresno. Completed in 1947, Millerton Lake has a storage capacity of 500,000 acre-feet. Water released through Friant Dam is diverted north through the Madera Canal, and south through the Friant-Kern Canal. The water supply to the Madera Canal is integrated with the operation of Hidden Dam on the Fresno River and Buchanan Dam on the Chowchilla River and serves areas on the east side of the San Joaquin Valley. The Friant-Kern Canal extends south to Kern County near Bakersfield, primarily serving areas in the Tulare Lake Basin. Additional water supplies are conveyed via the Friant-Kern Canal through coordinated operations with water supply facilities on the Kings, Kaweah, Tule, and Kern rivers and through exchange agreements between Friant-Kern and Cross Valley canal contractors. These water supplies are not associated with the CVP and the CVP merely facilitates exchanges or wheeling for CVP contractors if such actions do not affect the ability of the CVP to deliver contractual supplies.

b. Other Federal Projects. Other federal projects include those constructed by the U.S. Army Corps of Engineers (USCOE) or the USBR. These projects generally provide flood control and water supply benefits. Some of the larger projects in this category include: the Orland Project and Black Butte Reservoir on Stony Creek; the Solano Project on Putah Creek; Englebright Reservoir on the Yuba River; New Hogan Lake on the Calaveras River; and the four major reservoirs on the east side of the Tulare Lake Basin -- Pine Flat, Kaweah, Success, and Isabella.

The Orland Project includes East Park and Stony Gorge reservoirs which were built by the USBR in 1910 and 1928, respectively. They store surplus water for irrigation deliveries. Black Butte Reservoir was built in 1963 by the USCOE primarily for flood control and irrigation supply. It is financially integrated with the CVP and operations are coordinated between the CVP and the Orland Project. Black Butte Reservoir has a storage capacity of 143,000 acre-feet and East Park and Stony Gorge reservoirs each store about 50,000 acre-feet. The Solano Project, built by the USBR in 1959, stores water behind Monticello Dam in the 1.6 MAF Lake Berryessa in Napa County and conveys water through the Putah South Canal to agricultural and M&I users in Solano County. Narrows Dam (Englebright Reservoir) was built by the USCOE in 1941 as part of the Sacramento River Debris Control Project. The reservoir has a capacity of 70,000 acre-feet and is located on the Yuba River, downstream of New Bullards Bar Dam and Reservoir and Colgate Powerhouse. New Hogan Dam was also built by the USCOE and the lake, with a storage capacity of 317,000 acre-feet, provides flood control, agricultural and M&I water supplies, and recreational opportunities.

The reservoirs on the east-side tributaries to the Tulare Lake Basin were built by the USCOE to provide flood control; however, these reservoirs also provide water supply for irrigation of downstream agricultural lands. Pine Flat Dam and Reservoir on the Kings River, was completed in 1954 and has a capacity of 1.0 MAF. Success Lake stores 100,000 acre-feet on the Tule River and Lake Kaweah (Terminus Dam) stores 143,000 acre-feet on the Kaweah River. Lake Isabella, located on the Kern River northeast of Bakersfield, was constructed in 1953 and stores 568,000 acre-feet. These projects do not have federally-held water rights associated with them; local water users hold all rights.

c. State Water Project. Like the CVP, the SWP stores runoff from within the Sacramento Valley basin, releases stored water to the Sacramento River and the Delta, and pumps water out of the Delta for delivery to water users in the Bay area, the San Joaquin Valley, and Southern California. The SWP, operated by the DWR, includes 22 dams and reservoirs, 8 hydroelectric power plants, and 17 pumping plants. The major features of the SWP are shown in Figure III-6.

Plans for the SWP recognized that there would be a gradual increase in water demand and that some of the supply facilities could be deferred until later. Delta water transfer facilities were part of the original plan, and additional Sacramento and North Coast basin supply reservoirs were envisioned. Contracts were signed for an eventual delivery of 4.23 MAF. With the present level of development and current operating criteria, the SWP is capable of developing a reliable water supply of about 2.3 MAF.

The SWP delivers water to 29 long-term contractors. The service areas of these contracting agencies are shown in Figure III-7. Figure III-8 depicts the SWP water deliveries (excluding Feather River inbasin obligations) from 1967 to 1996. Generally, San Joaquin Valley use of SWP supply has been near full contract amounts since about 1980 (except during very wet years and during deficient-supply years). The San Joaquin Valley contractors are primarily agricultural users, with Kern County Water Agency having the largest contract entitlement (about 1.15 MAF/year). Southern California use, which is principally municipal and industrial, has only built up to about 60 percent of full entitlement. Metropolitan Water District of Southern California is the SWP's largest contractor, with annual entitlement of over 2 MAF.

The SWP also delivers water under negotiated settlement agreements to several agencies that are entitled to water from the Feather River under prior rights. Table III-4 shows the entitlement and average deliveries for the SWP's Feather River inbasin obligations.

The chief components of the SWP's water storage facilities are Oroville Dam and Lake Oroville which store winter and spring flows on the Feather River. Oroville Dam was completed in 1968 and the reservoir has a storage capacity of 3.5 MAF. Three smaller reservoirs, Lake Davis, Frenchman Lake, and Antelope Lake are located in the upper Feather River Basin in Plumas

Figure III-6
State Water Project Facilities

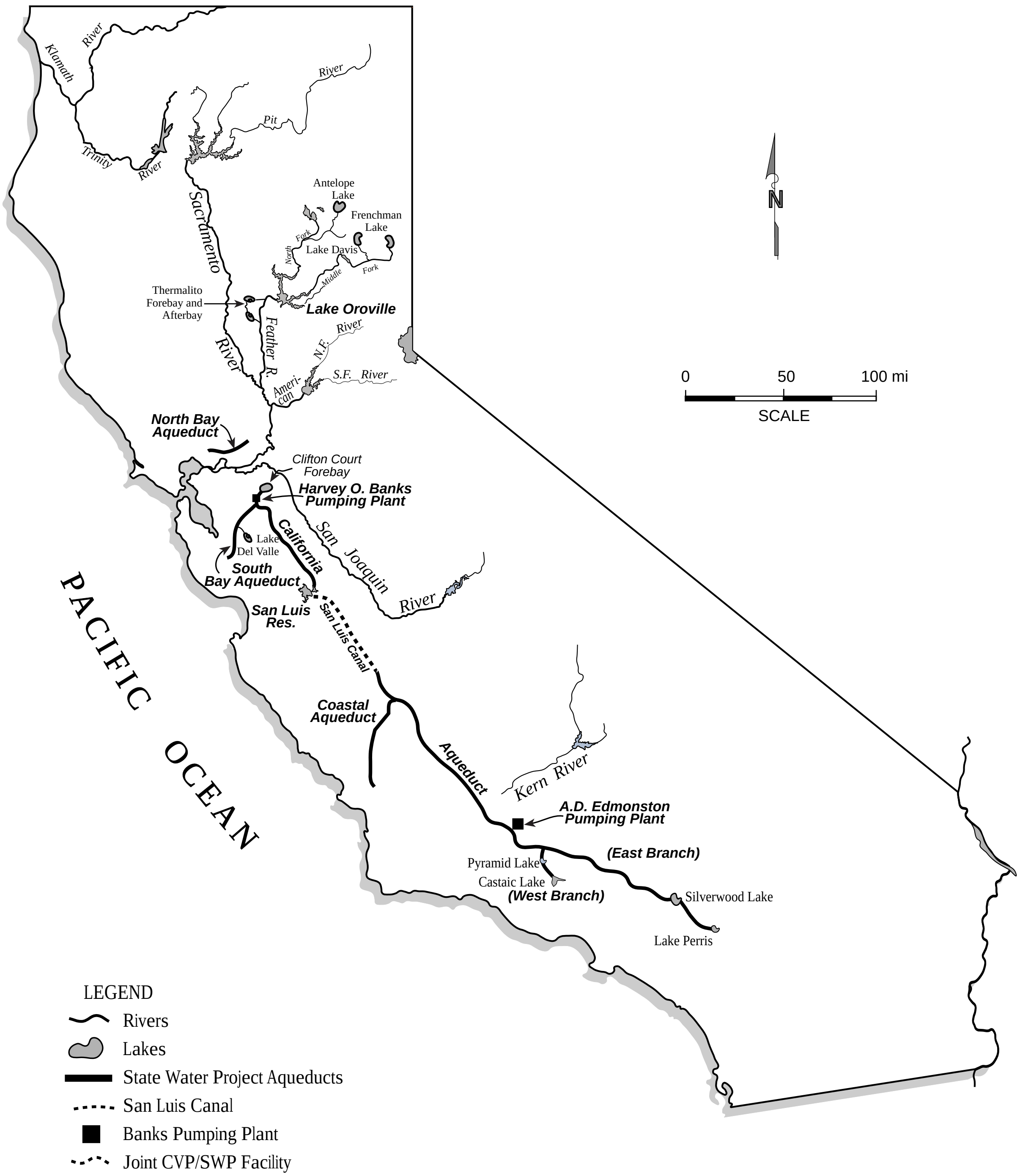
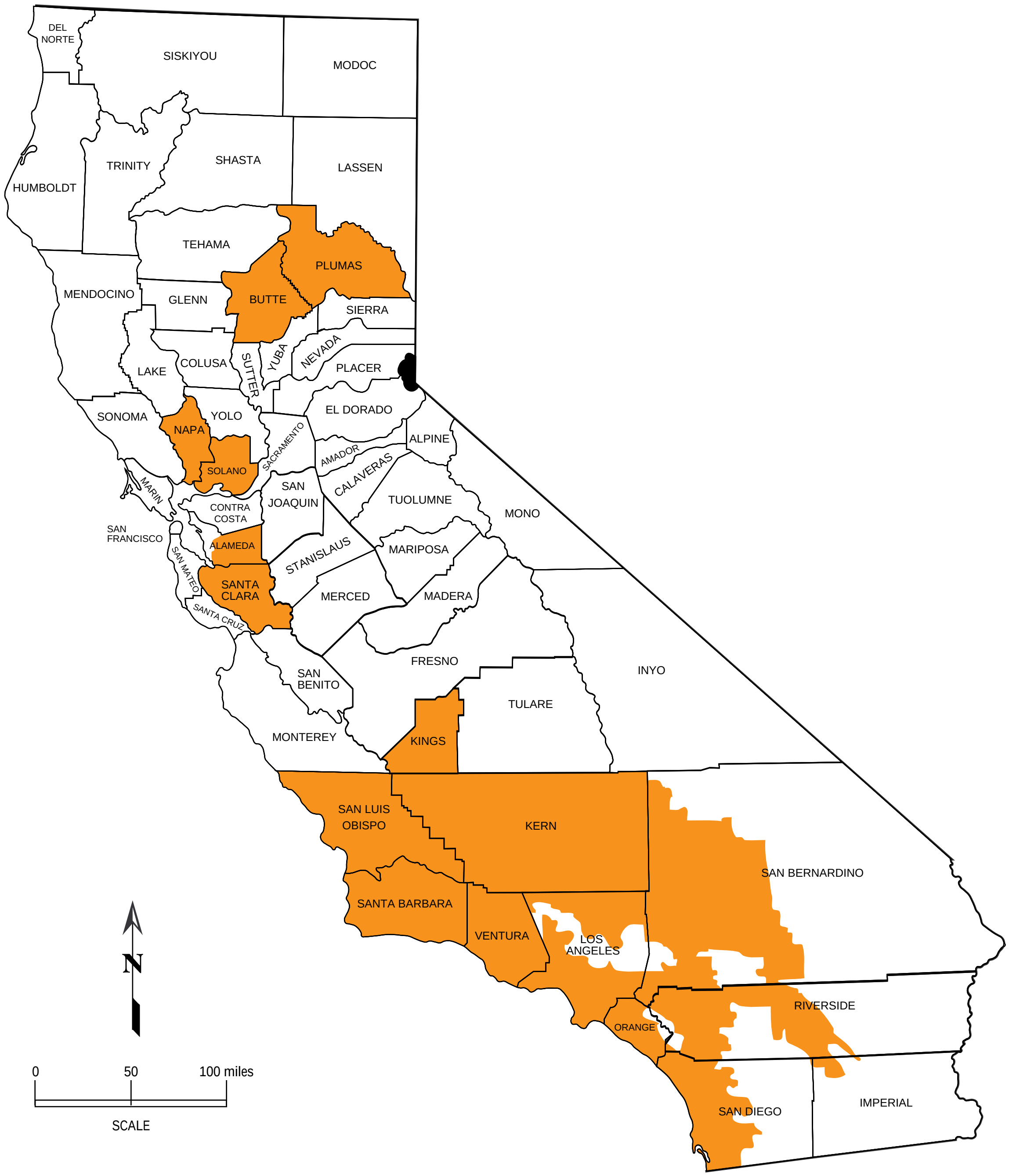


Figure III-7
State Water Project Service Area



Source: DWR, Bulletin 160-93 (1994)

County. These reservoirs are operated for recreational, fish and wildlife, and local water supply purposes. Below Oroville Dam, Thermalito Diversion Dam diverts water from the Feather River into the Thermalito Forebay for use in power generation. Water flows through Thermalito Powerplant and into Thermalito Afterbay, which regulates the return flow to the Feather River. Three of the four units at Thermalito Powerplant are reversible to allow pumping back into Thermalito Forebay.

Water stored in Lake Oroville is released into the Feather River, where it flows into the Sacramento River 21 miles above Sacramento, and from there, to the Delta. The SWP diverts a portion of this water from the Delta for export through the North and South Bay aqueducts and the California Aqueduct, and the remainder contributes to meeting minimum flow and water quality requirements.

The SWP diverts water from Barker Slough in the northern Delta, where it is pumped into the North Bay Aqueduct for municipal use in Solano and Napa counties. In the southern Delta, water is diverted into Clifton Court Forebay, then pumped at the Harvey O. Banks Delta Pumping Plant into the California Aqueduct. Clifton Court Forebay serves as a regulating reservoir for the pumping plant, allowing much of the pumping to occur at night when energy costs are lower. It also allows diversion from the Delta to be varied to minimize salinity intrusion. The John E. Skinner Delta Fish Protective Facility removes migrating fish drawn from the Delta with the pumping plant inflow.

Bethany Reservoir serves as an afterbay for discharges from the Banks Delta pumps and as a regulating reservoir for both the California and South Bay aqueducts. Water is pumped from Bethany Reservoir into the South Bay Aqueduct for delivery to urban and agricultural areas in Alameda and Santa Clara counties. Del Valle Reservoir provides 40,000 acre-feet of pumped-storage capacity for conservation and water delivery and also provides flood control and recreation benefits to the area. The lake is designed to store up to 77,000 acre-feet, but all storage above 40,000 acre-feet is reserved for floodwater encroachment.

The California Aqueduct is the main conveyance facility of the project and extends 444 miles from the Delta to Southern California. From the Delta, the California Aqueduct follows the west side of the San Joaquin Valley to the federal/State joint-use facilities of the San Luis Unit, including O'Neill Forebay and San Luis Reservoir (described previously under CVP). Water is pumped into San Luis Reservoir for storage during winter and released later when demand is greater and pumping restrictions reduce the amount of wateravailable from the Delta. From O'Neill Forebay, the joint-use portion of the California Aqueduct (San Luis Canal) extends south to the Kettleman City area. Two pumping plants (Dos Amigos and Buena Vista) provide the lift necessary for the aqueduct to continue south to the Tulare Lake Basin, where it serves most of the SWP agricultural users.

Figure III-8
State Water Project Deliveries, 1967 to 1996
(Millions of acre-feet)

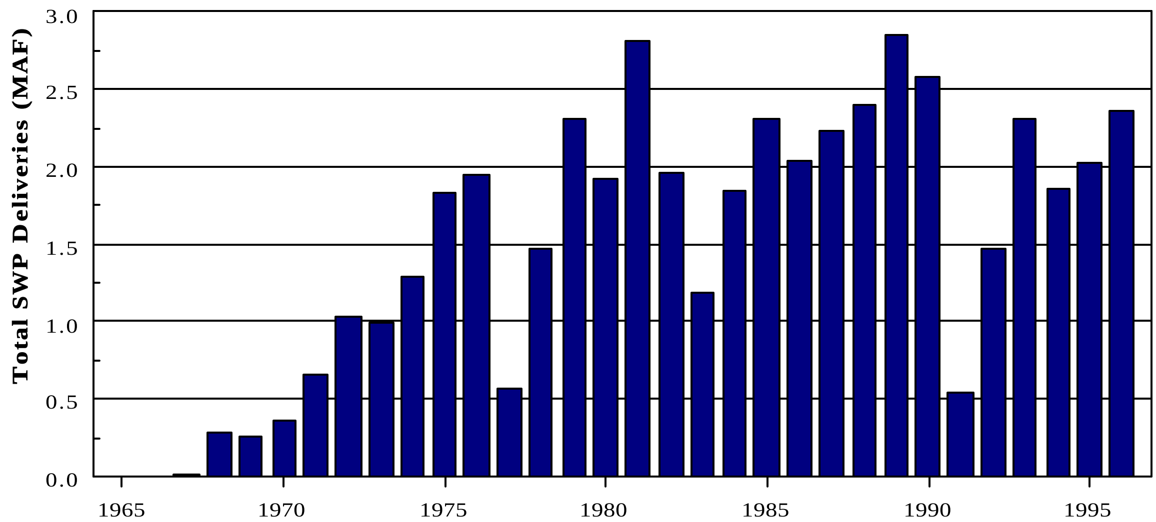


Table III-4.
SWP Feather River Inbasin Obligations

Contracting Agency	Annual Status (1)	Average Entitlement (Acre-feet)	Deliveries (2) (Acre-feet)
Joint Water District Board	WR	620,000	574,203
Western Canal Water District	WR	295,000	246,005
Garden Highway Mutual Water Co.	WR	18,000	16,260
Plumas Mutual Water Co.	WR	14,000	9,551
Oswald Water Co.	WR	3,000	0
Tudor Mutual Water Co.	WR	5,000	4,818
City of Yuba City	WS	9,600	185
County of Butte	WS	27,500	325

(1) WR - Water Settlement Contractors; WS - Water Supply Contractors
(2) Deliveries are averaged for the period 1982-1989, excluding 1983.

The Coastal Branch of the aqueduct splits from the main branch in the Tulare Lake Basin near Devil's Den. Construction of this branch was completed in 1997. It will convey water westerly over the Coast Ranges for use in the coastal areas of San Luis Obispo and Santa Barbara Counties.

Two additional pumping plants (Wheeler Ridge and Wind Gap) are required to move the water in the California Aqueduct to the southern end of the Central Valley. Water in the aqueduct is lifted nearly 2,000 feet into the Tehachapi Mountains by the A.D. Edmonston Pumping Plant and then flows through a series of four tunnels. The aqueduct then splits into the West Branch, which transports water through Pyramid Lake to Castaic Lake in Los Angeles County, and the East Branch, which delivers water to the Antelope Valley and Silverwood Lake, and terminates at Lake Perris in Riverside County.

d. Local Development. The majority of local water supply developments are in-basin diversion and storage projects. Most local surface projects are small, but there are some large local water projects constructed and operated by a wide variety of water and irrigation districts, agencies, municipalities, and companies. Initially, most local projects consisted of direct stream diversions. When these proved inadequate during the dry season, storage dams and reservoirs were built.

Some of the larger local storage projects on rivers tributary to the Central Valley include Bullards Bar Dam on the Yuba River, Exchequer Dam on the Merced, and Don Pedro Dam on the Tuolumne. Each original dam has been replaced by a new, larger version. Bullards Bar Reservoir, which is owned by Yuba County Water Agency, has a storage capacity of nearly one million acre-feet. Lake McClure, behind New Exchequer Dam, has a storage capacity of over one million acre-feet for Merced Irrigation District. New Don Pedro Reservoir, which has a storage capacity of over two million acre-feet, is owned and operated by the Turlock and Modesto Irrigation Districts.

Smaller storage projects have been built by a number of local water purveyors. Oroville-Wyandotte Irrigation District has facilities in the Feather River Basin, and South Sutter Water District operates Camp Far West Reservoir (104 TAF) on the Bear River. Nevada Irrigation District has several small reservoirs in the Yuba and Bear River Basins. Placer County Water Agency owns French Meadows (136 TAF) and Hell Hole (207 TAF) in the American River Basin, and Yolo County Flood Control and Water Conservation District stores water from Cache Creek in Clear Lake and Indian Valley Reservoir.

Numerous dams have been constructed on the Central Valley rivers primarily for hydroelectric power production. These facilities also incidentally regulate stream flows, create more usable water supplies during the dry summer months, and provide flood control and recreation benefits. Pacific Gas and Electric Company (PG&E) has facilities on the Pit and Feather river drainages, including Lake Almanor which has a storage capacity of over 1.1 million acre-feet. PG&E also operates facilities in the Yuba, American, Mokelumne, and Kings river watersheds. Southern California Edison has facilities on the upper San Joaquin River, and the Sacramento Municipal Utility District has facilities in the American River Basin. Some irrigation districts take advantage of the conservation of winter and spring runoff that is stored by the utilities and later released to meet peak summer demand for electricity.

As nearby sources of water were fully developed, urban areas began to reach out to more distant sources. In the 1920s, the East Bay cities of the San Francisco Bay Region turned to the Sierra Nevada watershed for additional water. The East Bay Municipal Utility District (EBMUD) completed the Mokelumne Aqueduct in 1929, bringing water from Pardee Reservoir and the Mokelumne River. Camanche Reservoir was added in 1963 below Pardee, and with the addition of a third barrel, the aqueduct's capacity was increased from 224,000 acre-feet per year to 364,000 acre-feet per year. The average annual import in 1990 was 245,000 acre-feet.

The City of San Francisco constructed O'Shaughnessy Dam on the upper Tuolumne River in 1923. In 1934, the City of San Francisco completed the Hetch Hetchy Aqueduct system, which diverts water from the Tuolumne River across the Central Valley to serve San Francisco, San Mateo, northern Santa Clara, and portions of Alameda counties. The current conveyance capacity of the Hetch Hetchy Aqueduct is about 330,000 acre-feet per year and average annual imports in 1990 were 267,000 acre-feet. The primary supply reservoirs are Hetch Hetchy, Lake Lloyd (Cherry Valley), and Lake Eleanor. The City of San Francisco also has exchange water storage in Don Pedro Reservoir which allows water that otherwise goes to the Turlock and Modesto irrigation districts to be diverted through the Hetch Hetchy Aqueduct.

e. Major Diversions. In addition to the surface water developments of the CVP, SWP, and local projects described above, there are substantial diversions from the Sacramento and San Joaquin river systems made by local water purveyors, irrigation districts, and individuals with water rights. Some of the diversions include elaborate facilities, such as diversion dams, pumping plants, fish screens, concrete-lined canals, and extensive distribution systems. Others are as simple as siphon tubes and irrigation ditches. Many of the major diverters listed below are covered by water right settlement contracts with the CVP and SWP.

Some of the major diverters on the upper Sacramento River include the Anderson-Cottonwood Irrigation District (ACID) and the Glenn-Colusa Irrigation District (GCID). Reclamation Districts 108 and 1004, Princeton-Codora-Glenn ID, Natomas Central Water Company, and Sutter Mutual Water Company make large diversions from the lower Sacramento River.

Western Canal Water District (WCWD) and Joint Water Board are among the major diverters from the Feather River. Joint Water Board is a consortium of four pre-1914 water right holders including Richvale ID, Biggs West Gridley WD, Butte WD, and Sutter Extension WD. Yuba County Water Agency (YCWA), South Sutter WD, Nevada ID, and PG&E have substantial rights to water from the Yuba and Bear rivers.

Urban areas within the area affected by this project receive water from a variety of sources. Most urban areas in the Central Valley rely on groundwater for municipal and industrial use. The City of Sacramento is the largest urban user of surface water supplies in the Central Valley, having water rights to the Sacramento and American rivers. As mentioned earlier, the City of San Francisco exports water from the Tuolumne River and EBMUD exports water from the Mokelumne River for use in the San Francisco Bay Region.

Much of the water supply from the San Joaquin River tributaries is diverted by several large irrigation districts for local use under senior water rights for direct diversion from those rivers. Oakdale ID and South San Joaquin ID divert water from the Stanislaus River. Turlock ID and Modesto ID take their water from the Tuolumne River below New Don Pedro Reservoir. Merced ID takes its water from the Merced River below Lake McClure. Chowchilla WD and Madera ID have rights to the Chowchilla and Fresno rivers, respectively. These districts provide most of the water for irrigation on the east side of the San Joaquin Valley.

The USBR and the DWR are the major diverters in the Delta. The USBR exports water from the Delta at Tracy Pumping Plant and CCWD diverts CVP water at Rock Slough and Old River under a water supply contract. The DWR exports from the Delta at Banks Delta Pumping Plant and Barker Slough to serve the SWP contractors. Table III-5 presents details of the USBR and DWR water right applications. Operation of the CVP and SWP Delta export facilities are coordinated to meet water quality and flow standards set by the Board, the USCOE, and more recently by federal fisheries agencies. However, there are approximately 1,800 local diversions within the Delta, many of which are made under claim of riparian right, which combine for potential instantaneous flow rates of more than 4,000 cfs.

Table III-6 lists the major water right holders that have diversion rights with a cumulative face value of 40,000 acre-feet per year or more from the Sacramento-San Joaquin river system. Table III-6 does not represent actual diversions by the water right holders. Actual diversions are frequently less than face value and there may be terms or conditions which limit actual diversions made under multiple permits held by the same water right holder. Table III-6 is not the basis for apportioning the responsibility for meeting the objectives of the 1995 Plan, but rather is included for illustrative purposes to demonstrate the relative magnitude of water rights held in the Central Valley.

Table III-5. Water Right Applications for the SWP and CVP in the Central Valley

DWR Water Right Applications *

Facility	Application	Priority	Max Dir Div (cfs)	Dir Div Season	Total Storage (AF)	Storage Season
Oroville	A005630	Jul 1927	1,400	1/1-12/31	380,000	9/1-7/31
Oroville	A014443	Aug 1951	1,360	1/1-12/31	3,500,000	9/1-7/31
			6,185	1/1-12/31	42,100	1/1-12/31
Banks Pumping Plant	A014445A	Aug 1951	2,115	1/1-12/31	44,000	
San Luis Facility	A017512	Mar 1957	0		1,100,000	1/1-12/31
North Bay Aqueduct	A017514A	Mar 1957	135	1/1-12/31	0	

USBR Water Right Applications

Facility	Application	Priority	Max Dir Div (cfs)	Dir Div Season	Total Storage (AF)	Storage Season
Contra Costa Canal	A009366	Aug 1938	200	1/1-12/31	0	
Contra Costa Canal	A009367	Aug 1938	250	1/1-12/31	0	
Contra Loma Reservoir	A022316	Oct 1965	0		5,400	10/1-6/30
Folsom Dam	A013370	Oct 1949	8,000	11/1-8/1	1,000,000	11/1-7/1
Folsom Dam	A013371	Oct 1949	700	11/1-8/1	300,000	11/1-7/1
Friant Dam **	A000023	Mar 1915	373	4/1-7/1	0	
Friant Dam **	A000234	Jan 1916	3,000	2/1-10/31	500,000	11/1-8/1
Friant Dam **	A001465	Sep 1919	3,000	2/1-10/31	500,000	11/1-8/1
Friant Dam **	A005638	Jul 1927	5,000	2/1-10/31	1,210,000	11/1-8/1
New Melones Dam	A014858A	Jun 1952	0		980,000	11/1-6/30
New Melones Dam	A014858B	Jun 1952	2,250	11/1-6/30	0	
New Melones Dam	A019304	Mar 1960	0		1,420,000	11/1-6/30
San Luis Facility	A015764	Mar 1954	0		1,000,000	11/1-4/30
Shasta Dam	A005626	Jul 1927	8,000	9/1-6/30	3,190,000	10/1-6/30
Shasta Dam	A009363	Aug 1938	1,000	1/1-12/31	310,000	10/1-7/1
Shasta & Keswick Dams	A009364	Aug 1938	9,000	1/1-12/31	1,303,000	10/1-6/30
Tracy Pumping Plant	A009368	Aug 1938	4,000	1/1-12/31	0	
Whiskeytown Dam	A017376	Nov 1956	3,600	11/1-4/1	250,000	11/1-4/1

* Any of the water permitted for diversion out of the Feather may also be taken directly at Banks without any initial diversions at Oroville. Any of the SWP's permitted storage quantities at Oroville or Banks may be stored in or re-stored San Luis. DWR stores water diverted under A17512 at any of its south of Delta facilities.

** Status as an export project vs. an inbasin project is an issue in the water right hearing.

Table III-6. Major Water Right Holders in the Central Valley

Includes applicants with a cumulative face value of or greater than 40,000 acre-feet
Water right holders in bold type include the Sacramento River Water Settlement Contractors, San Joaquin River Exchange Contractors, and others with contractual arrangements with either the CVP or SWP.

Water Right Holder	Cumulative Face Value	Cumulative Dir Div	Cumulative Storage	Points of Diversion
Turlock I D & Modesto I D	3,816,290	7,600	2,788,600	Tuolumne River
Pacific Gas & Electric Company	2,953,993	3,955	102,941	Sacramento-San Joaquin Delta Watershed
Nevada I D	2,586,397	3,816	441,607	Yuba and Bear River Watersheds
Yuba County Water Agency	2,350,000	1,593	1,250,000	Yuba River
Merced I D	2,339,523	5,757	879,025	Merced River
City of Sacramento	1,968,547	2,410	589,000	American and Sacramento Rivers
Oakdale I D & South San Joaquin ID	1,672,521	1,818	470,949	Stanislaus River
Placer County Water Agency	1,289,309	2,025	315,000	American River
Glenn-Colusa I D	1,282,972	3,072	0	Sacramento River
Central California I D	1,256,508	1,900	0	Mendota Pool on San Joaquin River
Oroville-Wyandotte I D	1,123,362	1,435	331,312	Feather and Yuba Rivers
Joint Water Districts Board	970,200	2,000	0	Feather River
East Bay Municipal Utilities District	931,874	510	562,950	Indian Slough and Mokelumne River
Calaveras County Water District	818,745	1,403	470,324	Stanislaus River and tributaries
Yolo County F C & W C District	751,774	1,128	614,000	Cache Creek, Trib to Yolo Bypass
City & County of San Francisco	679,453	940	115	Tuolumne River
Western Canal Water District	654,214	1,203	0	Feather River
Sutter Mutual Water Company	507,443	937	0	Sacramento River
Reclamation District #108	472,722	1,010	0	Sacramento River
Gallo Glass Company	447,765	823	0	Merced River
San Luis Canal Company	359,964	600	0	San Joaquin River
Anderson-Cottonwood I D	289,080	400	0	Sacramento River
Madera I D	261,449	463	0	Fresno River
Woodbridge I D	224,551	436	0	Central Delta Channels
Banta-Carbona I D	216,104	425	0	South Delta and San Joaquin River
South Sutter Water District	193,155	669	98,370	Sacramento River
West Stanislaus I D	189,456	262	0	San Joaquin River
Los Molinos Mutual Water Co.	187,902	260	41,000	Tributaries to Sacramento River
Parrott Investment Company	182,345	363	0	Butte Creek
Georgetown Divide Pub. Util. Dist.	182,343	255	44,000	South Fork American River
Provident I D	168,771	463	0	Sacramento River
Kelsey	160,182	350	0	Merced River
Stevinson Water District	154,531	317	0	Merced and San Joaquin Rivers
Natomas Central Mutual Water Co.	148,044	631	0	Sacramento River
Sutter Extension Water District	142,989	397	0	Feather River
Columbia Canal Company	138,877	210	0	San Joaquin River
U S Fish & Wildlife Service	134,191	235	16,521	Sacramento-San Joaquin Delta Watershed
Conaway Conservancy Group	132,567	409	0	Sacramento River
Hardesty	127,082	397	0	North Delta Channels

Table III-6 (cont.) Major Water Right Holders in the Central Valley

Water Right Holder	Cumulative Face Value	Cumulative Dir Div	Cumulative Storage	Points of Diversion
Schluter	126,271	504	5,000	Pit River Watershed
Browns Valley I D	117,440	136	60,000	Yuba River
Princeton-Codora-Glenn I D	116,741	290	0	Sacramento River
San Juan Suburban Water District	112,019	155	0	American River at Folsom Lake
Contra Costa Water District	105,490	115	105,490	Western Delta Channels
Premiere Farmland Partners III	103,649	100	0	Sacramento River
Reclamation District #1004	103,609	306	0	Butte Creek and Sacramento River
Reclamation District #999	97,778	290	0	North Delta Channels
M & T Incorporated	89,952	129	0	Butte Creek
Chowchilla Water District	83,449	101	50,000	Chowchilla River
Carman	81,087	112	0	Tribs to S. Fork American River
Wild Goose Club	75,735	250	0	Butte Creek
Jackson Valley I D	74,036	160	36,000	Tribs to Dry Creek / Mokelumne River
Maxwell I D	72,268	186	0	Sacramento River
Hot Springs Valley I D	68,400	0	68,400	Pit River Watershed
East Contra Costa I D	65,877	136	0	South Delta Channels
Edwards	65,043	90	0	Antelope Creek
Pescadero Recl. Dist. #2058	64,215	177	0	South Delta Channels
Patterson Water District	63,558	150	0	San Joaquin River
Pelger Mutual Water Company	62,527	147	0	Sacramento River
Reclamation District #2037	61,755	85	0	South Delta Channels
Stanford Vina Ranch Irrig. Co.	61,439	145	0	Deer Creek
Los Rios Farms Incorporated	60,622	169	0	Putah Creek
Collins Pine Company	60,201	83	0	N. Fork Feather River
Reclamation District #548	59,261	82	0	San Joaquin River Delta Channels
Tuolumne Utilities District	57,816	80	0	Tribs to Tuolumne River
Reclamation District #2039	56,804	79	0	San Joaquin River Delta Channels
McArthur	54,519	78	0	Pit and Fall Rivers
Belcher	53,893	223	25	Cosumnes River
Reclamation District #2038	51,846	72	0	San Joaquin River Delta Channels
California Dept. of Fish & Game	49,449	142	0	Sacramento-San Joaquin Delta Watershed
Willow Creek Mutual Water Co.	49,005	90	0	Central Drain, Colusa Basin Drain trib.
Olive Percy Davis Trust	48,527	128	0	Sacramento River
Zumwalt Mutual Water Co.	47,275	123	0	Colusa Basin Drain
Church of Jesus Christ of L D S	44,567	80	0	Sacramento River, South Delta Channels
Deer Creek I D	43,362	60	0	Deer Creek
The Prudential Insurance Co.	42,602	141	10	Putah Creek
Hallwood Irrigation Company	42,570	100	0	Yuba River
Elna Scohr Incorporated	41,669	115	0	Butte Creek
Lake County F C & W C D	41,000	0	41,000	Cache Creek
Maine Prairie Water District	40,298	108	0	Yolo Basin and North Delta Channels

2. Aquatic Resources

Historical fishery resources within the Central Valley were considerably different than the fisheries present today. Many native species have declined in abundance and distribution, and several introduced species have become well established. The decline of many species is due, in large part, to the alterations made to habitat as a result of human activities, the introduction of exotic species, and over-fishing. Early alterations to habitat included hydraulic mining, dredging, levee building, and dam construction. Operation of water storage and diversion facilities has had a significant impact on several species. Other factors that affect the fisheries of the Central Valley include agricultural, urban, and industrial development, grazing, mining, and logging, and the pollution generated by these activities.

A wide variety of fish are found throughout the waterways of the Central Valley. Many are common to several of the regions that will be described later in this chapter. Some, such as the anadromous fish, are found in particular parts of the San Francisco Bay/Sacramento-San Joaquin Delta and tributary rivers and streams only during certain stages of their life cycle.

Many of the fish species and communities found throughout the Central Valley could be affected by the implementation of the SWRCB water right decision. For the purposes of this EIR, the effects will be considered for anadromous species, other special-status species, and reservoir communities. Anadromous species include chinook salmon, steelhead trout, white and green sturgeon, striped bass, and American shad. Although striped bass and American shad are introduced species, both are abundant and contribute substantially to California's recreational fishery. These anadromous fish populate Central Valley waterways during the freshwater stages of their life cycles.

Delta smelt, Sacramento splittail, and longfin smelt are species of concern because of their declining numbers in the Delta and their federal status as threatened (delta smelt and Sacramento splittail) and species of concern (longfin smelt) under the ESA. All three species are native, and their abundance and distribution indicate the ecological health of the Sacramento-San Joaquin River system, the Delta, and the Bay.

Reservoirs have become one of the major fish habitats in the Central Valley since the development of the region's surface water projects. The nature of each reservoir and its fish fauna is determined by its elevation, size, location, and water quality. In general, reservoirs are less productive per surface acre than lakes because their typically deep, steep-sloped basins and fluctuating water levels greatly limit habitat diversity.

Warm-water reservoirs are typically suitable for black bass, sunfish, and catfish. Cold-water reservoirs have a zone of deep, well-oxygenated water cool enough in summer to be suitable for trout. Many of the Central Valley reservoirs lie at the mid-level elevations in the foothills and have characteristics of both warm-water and cold-water impoundments. These reservoirs provide greater fishing diversity, although extensive drawdowns limit species dependent on shallow-water habitat, such as black bass and sunfish. Reservoirs may enhance downstream fisheries by controlling the temperature and timing of releases.

The following life history summaries of selected fish in the Central Valley rivers are presented here to avoid repetition in the regional discussions that follow.

a. Chinook Salmon. Chinook salmon typically return to their natal stream to spawn. The timing of spawning of the four races of chinook salmon in Central Valley rivers is as follows:

1) Adult fall-run chinook salmon migrate through the Sacramento-San Joaquin Delta and into Central Valley rivers from July through December and spawn from October through December. Peak spawning activity usually occurs in October and November.

2) Adult late-fall run chinook salmon migrate through the Delta and into the Sacramento River from October through March or possibly April and spawn from January through April. Peak spawning activity occurs in February and March.

3) Adult winter-run chinook salmon migrate through the Delta from late November through June and into the Sacramento River from December through July. Winter-run chinook salmon do not spawn immediately but remain in the river up to several months before spawning. Spawning occurs from April through July, with peak spawning activity in May and June.

4) Adult spring-run chinook salmon migrate through the Delta from January through June, enter the Sacramento River and its tributaries from March through September, and remain in the rivers up to several months before spawning. Spawning occurs from August through October, with peak spawning activity in September. Table III-7 summarizes the timing of chinook salmon occurrence in the Sacramento-San Joaquin Delta by race and lifestage.

Chinook salmon lay their eggs in the gravel of the stream bottom where they incubate for generally 6 to 9 weeks depending on water temperature. The newly emerged fry remain in the gravel for another 2 to 4 weeks. The timing of rearing and outmigration is different for the various runs of chinook salmon. Rearing salmonids feed on a variety of aquatic and terrestrial insects and other small invertebrates, and newly emerged fry are sometimes prey of older steelhead. Juveniles begin the smolting process as they migrate seaward. Smolting consists of physiological, morphological and behavioral changes that stimulate emigration and prepare the salmonids for ocean life. Chinook salmon generally outmigrate within the first year and spend 2 to 4 years in the ocean before returning to spawn.

Winter-run chinook salmon are listed as endangered under both the state and federal endangered species acts. Spring-run chinook are listed as threatened under both the state and federal endangered species acts. Fall-run and late-fall run chinook, Central Valley Evolutionarily Significant Units, are considered candidate species under the federal Endangered Species Act.

Table III-7
Timing of Occurrence of Chinook Salmon by Race and Lifestage in the Sacramento-San Joaquin Delta

	Sacramento River				San Joaquin River
Lifestage	Fall-run	Late fall-run	Winter-run	Spring Run	Fall-run
Adult upstream migration	July - December[1]	October - April[1]	Late November - June[2]	January - June[2]	July - December[1]
Juvenile Rearing and Emigration	January - June[1] (fry/smolts) October - December[1] (yearlings)	April - December[1]	September - May[2]	October - June[2] (young-of-the-year) mid-October - March (yearlings)	January - June[1]

Sources: 1. USBR 1997c
2. DFG 1998

b. **Steelhead**. Steelhead typically return to their natal streams to spawn. There is considerable variation in steelhead run timing. Steelhead stocks in the Central Valley are all winter steelhead. Adults migrate upstream through the Delta and into the Sacramento River and tributaries during most months of the year. Steelhead begin moving through the mainstem in July, peak near the end of September, and continue migrating through February or March. A few adults have also been observed in April, May, and June. Steelhead in the Sacramento River basin spawn primarily from January through March, but spawning can begin as early as late December and can extend through April.

The timing of steelhead runs in the San Joaquin River basin is assumed to be similar to the Sacramento River basin. However, currently there is evidence of only a small anadromous run of steelhead in the basin and the origin of these fish is not known.

As for chinook salmon, steelhead lay their eggs in the gravel of the stream bottom where they incubate for approximately 6-9 weeks depending on water temperature. The newly emerged fry remain in the gravel for another 2-4 weeks. The timing of rearing and outmigration is different for the various runs of steelhead. Rearing salmonids feed on a variety of aquatic and terrestrial insects and other small invertebrates, and newly emerged fry are sometimes prey of older steelhead. Juveniles begin the smolting process as they migrate seaward. Smolting consists of physiological, morphological and behavioral changes that stimulate emigration and prepare the salmonids for ocean life.

The life history of steelhead differs from that of Pacific salmon in several ways. Unlike salmon, steelhead do not necessarily die after spawning, and a small portion of these survive to become repeat spawners. Post-spawning survival rates are generally low, and vary considerably between populations. Juvenile steelhead also have a longer freshwater rearing requirement (usually from one to three years) and both adults and juveniles are much more variable in the length of time they spend in fresh and salt water. Some individuals may remain in a stream, mature, and even spawn without ever going to sea, others may migrate to the ocean at less than a year old, and some may return to freshwater after spending less than a year in the ocean.

Due to significant declines in steelhead populations in the Central Valley, the NMFS listed the Central Valley, California, Evolutionarily Significant Unit as threatened under the ESA on March 19, 1998.

c. Striped Bass. Striped bass inhabit fresh and ocean water and require riverine habitat for spawning with currents sufficient to keep the eggs suspended off the bottom. Striped bass are considered adults at 3 years old and spawn in the lower reaches of the Sacramento and San Joaquin Rivers. Spawning begins first in the Delta, usually in mid-to-late April, and continues sporadically over 3-5 weeks. They are mass spawners, broadcasting eggs and sperm. The eggs are slightly denser than fresh water and in the absence of current, sink slowly to the bottom. Eggs hatch in approximately 2 days at 18-19EC. Larval stages last 4-5 weeks.

The striped bass rear in the Delta eating progressively larger prey as they grow. As the bass grow, the diet of juvenile bass shifts more to fish and becomes similar to the diet of adult striped bass, which includes small fish and invertebrates. Adult bass are found throughout the year in the Sacramento and San Joaquin rivers, the Delta, San Francisco Bay and the ocean but they show definite migration patterns. In the fall, adult striped bass migrate upstream to Suisun Bay and the Delta where they overwinter. During the spring, they disperse throughout the Delta and into the tributary rivers to spawn. Migration back to the Delta, Suisun Bay and San Francisco Bay occurs during summer. After the mid-1960's, most striped bass inhabit Suisun Bay and the Delta during summer and fall, and migration to San Francisco Bay and the Pacific Ocean is believed to have declined. However, data from Bennett and Howard (1997) suggest many older bass move to the ocean during warm El Niño events (i.e., 1976-77).

d. American Shad. Generally, American shad are anadromous, spending most of their life in the ocean and returning as adults to spawn in rivers. The adult spawning migration occurs primarily from April through June, with most spawning taking place in the American, Feather, Yuba, and upper Sacramento rivers. Some spawning occurs in moderate currents sufficient to keep eggs suspended off the bottom. The young can rear for several months in the Feather and Sacramento rivers or migrate downstream soon after hatching, lingering in the Delta for several weeks to several months. American shad become sexually mature while in the ocean at an average age of 3-5 years. Adult American shad initiate their spawning migration as early as February, however most adults do not migrate into the Delta until March or early April.

The peak spawning migration into upstream habitat takes place when water temperatures increase, usually in late May or early June. American shad spawn exclusively in freshwater, although spawning may be possible in brackish water. It is not clear whether flows or water temperatures are the primary factors responsible for attracting shad into the streams. Migration appears to decline after water temperature exceeds 68°F, usually in early July. Peak migration in the Sacramento river upstream of the Feather River occurs in May and angling surveys indicate that peak migration in the Feather and Yuba rivers occurs during June.

The newly hatched larvae are pelagic and most abundant at the water surface. They feed on zooplankton within 4-5 days of hatching. Newly hatched larvae are found downstream of spawning areas and can be rapidly transported downstream by river currents because of their small size. Some juvenile shad appear to rear in the Delta for up to a year or more before emigrating to the ocean. While in the Delta, juvenile shad are opportunistic feeders and prey on various invertebrates. Presumably, all juvenile shad eventually emigrate to the ocean, because immature shad greater than 8 inches long are rarely caught in the Delta. Seaward migration of juvenile shad in the Delta begins in late June and continues through November, with peak migration occurring between September and November.

Little is known about the oceanic ecology and behavior of juvenile and adult American shad. They are found in the Pacific Ocean from Baja California to Alaska; however, they are seldom found south of Monterey.

e. **<u>White Sturgeon</u>**. White sturgeon are the most abundant sturgeon in the Bay-Delta system and support a popular sportfishery. White sturgeon are long-lived and mature some time after 10 years of age. Their longevity allows them to reach large sizes; the California sport fishing record is a 468-pound fish that was probably 40 to 50 years old when caught in the mid-1980’s.

In the Sacramento-San Joaquin system, a portion of the adult white sturgeon population moves upstream to freshwater environments to spawn between February and May. The species spawns in the Sacramento River between mid-February and late May, with peak spawning occurring between March and April. Most females spawn for the first time at approximately age 15 and could spawn as infrequently as every five years thereafter.

Spawning habitat requirements for white sturgeon in the system have not been definitively identified. Apparently sturgeon broadcast spawn in swift water. It is not known if eggs are fertilized in the water column or after they contact the bottom. The current initially disperses the adhesive eggs, which sink and adhere to gravel and rock on the bottom. The adhesive properties of the eggs are adaptive to spawning and retention of eggs in swift current environments. Hatching time depends primarily on water temperature. Egg incubation can last 4 to 14 days post-fertilization; yolk depletion can occur 15 to 30 days post-fertilization. Optimum temperatures for incubation and hatching range from 52 to 63 degrees F; higher temperatures result in greater mortality and premature hatching.

After hatching, yolk sac larvae swim up into the water column. Currents transport larvae downstream of the spawning area. The diet of white sturgeon changes as the fish become larger. Young-of-the-year sturgeon feed on a variety of prey, including small crustaceans and insect larvae, and potentially small fish fry. *Corophium* spp. and *Neomysids* are the most common prey of sturgeon captured in the Sacramento-San Joaquin River system. As the fish grow, the diet becomes more diverse and includes several benthic invertebrates and seasonally abundant food items, such as fish eggs or fry.

There is no defined age or size at which juvenile white sturgeon enter the estuarine environment. Adult and subadult sturgeon inhabit estuarine areas year-round. Adult sturgeon are found in Suisun, San Pablo, and San Francisco bays and in the Delta. Distribution in the Delta is thought to depend primarily on river flow and resulting salinity regimes. The center of the population is further upstream in low river flow years and downstream in high flow years.

In the Bay-Delta system, the major factors likely to be negatively affecting white sturgeon abundance are increased sport harvest, reduction in Delta outflow, entrainment, and toxic substances. A significant positive correlation has been found between white sturgeon year-class strength and Delta outflow in spring and early summer (April to July).

f. **Green Sturgeon.** San Francisco Bay, San Pablo Bay, Suisun Bay, and the Delta support the southernmost reproducing population of green sturgeon. White sturgeon are the most abundant sturgeon in the system and green sturgeon have always been comparatively uncommon. Habitat requirements of green sturgeon are poorly known, but spawning and larval ecology probably are similar to that of white sturgeon. Adult green sturgeon are more marine than white sturgeon, spending limited time in estuaries or freshwater.

Indirect evidence indicates that green sturgeon spawn mainly in the Sacramento River; spawning has been reported in the mainstem river as far north as Red Bluff. Spawning times in the Sacramento River are presumed to be March – July, with a peak from mid-April to mid-June. Adult sturgeon are in the river, presumably spawning, when temperatures range between 8 – 14 °C. Preferred spawning substrate likely is large cobble, but can range from clean sand to bedrock. Eggs are broadcast spawned and externally fertilized in relatively high water velocities and at depths >3 m. Female green sturgeon produce 60,000 – 140,000 eggs, about 3.8 mm. in diameter. Eggs probably hatch around 196 hours after spawning, and larvae are 8 – 19 mm. long. Juveniles likely range in size from 2.0 to 150 cm. Juveniles migrate to sea before two years of age, primarily during the summer and fall. They remain near estuaries at first, but can migrate considerable distances as they grow larger.

Green sturgeon grow approximately 7 cm per year until they reach maturity at 130-140 cm, around age 15-20. Thereafter growth slows down. The largest fish have been aged at 40 years, but this is probably an underestimate. Adults can reach sizes of 2.3 m FL and 159 kg, but in San Francisco Bay, most are probably less than 45 kg.

Juvenile and adult green sturgeon are benthic feeders and may also take small fish. Juveniles in the Delta feed on opossum shrimp (*Neomysis mercedis*) and amphipods (*Corophium* sp.)
The green sturgeon is apparently reduced in numbers throughout its range, although evidence is limited. Rough estimates of the abundance of green sturgeon longer than 102 cm. in the estuary between 1954 and 1991 range from 200 to 1,800 fish, based on intermittent studies by DFG. There is no direct evidence of a decline in the Sacramento River. However, the population is so small that a collapse could occur and hardly be noticed because of the limited sampling.

In the Bay-Delta system, the major factors likely to be negatively affecting green sturgeon abundance are sport fisheries, modification of spawning habitat, entrainment, and toxic substances. Green sturgeon are a federal Species of Concern and state Species of Special Concern.

g. **Delta Smelt**. The delta smelt generally spend their entire life cycle in the open, surface waters of the Sacramento-San Joaquin Delta and Suisun Bay. The delta smelt are small (typically 2.5 inches, maximum length about 5 inches), rarely live more than one year, have low fecundity, and are not taken in recreational or commercial fisheries. Delta smelt are euryhaline (a species that tolerates a wide range of salinity) fish that rarely occur in water of more than 10-12 parts per thousand salinity. Live fish are nearly translucent and have a steely-blue sheen to their sides.

Delta smelt are endemic to the upper Sacramento-San Joaquin Estuary. They occur in the Delta primarily below Isleton on the Sacramento River, below Mossdale on the San Joaquin River, and in Suisun Bay. They move into fresh water when spawning (ranging from January to July) and can occur in: (1) the Sacramento River as far upstream as Sacramento, (2) the Delta channels of the Mokelumne River, (3) the Cache Slough region, (4) the Delta, and (5) the Montezuma Slough area of the estuary. During the recent 6-year drought period, the center of delta smelt abundance was the western Delta. However, in water years 1993, 1995, 1997, and 1998, their distribution shifted into Suisun Bay and areas farther downstream. During high outflow periods, they also may be washed into San Pablo Bay, but they do not establish permanent populations there. Delta smelt are captured seasonally in the channels of Suisun Marsh.

Most spawning occurs in sloughs and shallow edge-waters of channels in the upper Delta. Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs, and the Sacramento River in the Delta, and tributaries of northern Suisun Bay. Laboratory observations have indicated that delta smelt are broadcast spawners and that the eggs sink to the bottom and attach to the substrate. Newly hatched delta smelt have a large oil globule that makes them semi-buoyant, allowing them to maintain themselves just off the bottom, where they feed on rotifers and other microscopic prey. Once the swimbladder develops, larvae become more buoyant and rise up higher in the water column. At this stage (0.6-0.7 inch total length), most are presumably washed downstream until they reach the mixing zone or the area immediately upstream of it. Growth is rapid and juvenile fish are 1.6-2.0 inches long by August.

Delta smelt feed primarily on planktonic copopods, cladocerans, and amphipods (all small crustaceans commonly used by fish for food), and, to a lesser extent, insect larvae. Delta smelt are a minor prey item of juvenile and subadult striped bass, and have been reported in the stomach contents of white catfish and black crappie.

Delta smelt were once one of the most common pelagic fish in the upper Sacramento-San Joaquin estuary. While their annual abundance has fluctuated greatly in the past, between 1981 and 1990, delta smelt abundance was consistently low. Indices in 1991, 1993, and 1995 were more than double those of the 1981-1990 period; indices in 1993 and 1995 were the sixth and seventh highest on record. The causes of decline are multiple and synergistic, including: reduction in flows; entrainment losses to water diversions; high outflows; changes in food organisms; toxic substances; disease, competition, and predation; and, loss of genetic integrity. The decline was precipitous in 1982 and 1983 due to extremely high outflows and continued through the drought years 1987-1992. In 1993, numbers increased considerably, apparently in response to a wet winter and spring.

The USFWS listed the delta smelt as threatened on March 5, 1993 and issued a formal biological opinion for SWP and CVP operations on May 26, 1993. The DFG listed the delta smelt as threatened on December 9, 1993. USFWS issued an amended biological opinion for SWP and CVP operations on February 4, 1994 and again on March 3, 1995.

h. **Longfin Smelt**. The longfin smelt is a small, planktivorous fish that is found in several Pacific coast estuaries from San Francisco Bay to Prince William Sound, Alaska. Until 1963, the population in San Francisco Bay was thought to be a distinct species. Within California, longfin smelt have been reported from Humboldt Bay and the mouth of the Eel River. In California, the largest longfin smelt reproductive population inhabits the Bay/Delta Estuary.

Longfin smelt can tolerate salinities ranging from fresh water to seawater. Spawning occurs in fresh to brackish water over sandy-gravel substrates, rocks, or aquatic vegetation. In the Bay/Delta Estuary, the longfin smelt life cycle begins with spawning in the lower Sacramento and San Joaquin rivers, the Delta, and freshwater portions of Suisun Bay. Spawning may take place as early as November and extend into June, with the peak spawning period occurring from February to April. The eggs are adhesive and, after hatching, the larvae are carried downstream by freshwater outflow to nursery areas in the

lower Delta and Suisun and San Pablo bays. Adult longfin smelt are found mainly in Suisun, San Pablo, and San Francisco bays, although their distribution is shifted upstream in years of low outflow.

With the exceptions that both longfin smelt and delta smelt spawn adhesive eggs in river channels of the eastern Estuary and have larvae that are carried to nursery areas by freshwater outflow, the two species differ substantially. Consistently, a measurable portion of the longfin smelt population survives into a second year. During the second year of life, they inhabit San Francisco Bay and, occasionally, the Gulf of the Farallones; thus, longfin smelt are often considered anadromous.

Longfin smelt are also more broadly distributed throughout the Estuary and are found at higher salinities than delta smelt. Because longfin smelt seldom occur in fresh water except to spawn, but are widely dispersed in brackish waters of the Bay, it seems likely that their range formerly extended as far up into the Delta as salt water intruded. The easternmost catch of longfin smelt in fall mid-water trawl samples has been at Medford Island in the Central Delta. A pronounced difference between the two species in their region of overlap in Suisun Bay is by depth; longfin smelt are caught more abundantly at deep stations (>10 m), whereas delta smelt are more abundant at shallow stations (<3 m).

The main food of longfin smelt is the opossum shrimp, *Neomysis mercedis*, although copopods and other crustaceans are important at times, especially to small fish. Longfin smelt, in turn, are eaten by a variety of predatory fishes, birds, and marine mammals.

Longfin smelt were once one of the most common fish in the Sacramento-San Joaquin Estuary. Their abundance has fluctuated widely in the past but since 1982, abundance has declined significantly, reaching the lowest levels during drought years. Abundance improved substantially in 1995, but was again relatively low in 1996 and 1997. The number of longfin smelt also has declined in relative abundance to other fishes, dropping from first or second in abundance in most trawl surveys during the 1960s and 1970s, to being seventh or eighth in abundance. The causes of decline are multiple and synergistic, including: reduction in outflows; entrainment losses to water diversions; climatic variation; toxic substances; predation; and introduced species.

i. **Sacramento Splittail**. The Sacramento splittail is a large minnow endemic to the Bay/Delta Estuary. Once found throughout low elevation lakes and rivers of the Central Valley from Redding to Fresno, this native species now occurs in the lower reaches of the Sacramento and San Joaquin rivers and tributaries, the Delta, Suisun and Napa marshes, Sutter and Yolo bypasses, and tributaries of north San Pablo Bay. Although the Sacramento splittail is generally considered a freshwater species, the adults and sub-adults have an unusually high tolerance for saline waters (up to 10-18 ppt) for a member of the minnow family. The salt tolerance of splittail larvae is unknown, but they have been observed in water with salinities of 10-18 ppt. Therefore, the Sacramento splittail is often considered an estuarine species. When splittail were more abundant, they were commonly found in Suisun Bay and Suisun Marsh.

The Sacramento splittail, which has a high reproductive capacity, can live 5-7 years and generally begin spawning at 2 years of age. Spawning, which seems to be triggered by increasing water temperatures and day length, occurs over beds of submerged vegetation in slow-moving stretches of water, such as flooded terrestrial areas and dead-end sloughs. Adults spawn from February through May in the Delta, upstream tributaries, Napa Marsh, Napa and Petaluma rivers, Suisun Bay and Marsh, and the Sutter and Yolo bypasses. Hatched larvae remain in shallow, weedy areas until they move to deeper offshore habitat later in the summer. Young splittail may occur in shallow and open waters of the Delta and San Pablo Bay, but they are particularly abundant in the northern and western Delta.

Splittail are benthic foragers that feed extensively on opossum shrimp (*Neomysis mercedis*) and opportunistically on earthworms, clams, insect larvae, and other invertebrates. They are preyed upon by striped bass and other predatory fish in the Estuary. The splittail is commonly used by anglers as bait when fishing for striped bass.

Splittail have disappeared from much of their native range because dams, diversions, and agricultural development have eliminated or drastically altered much of the lowland habitat these fish once occupied. Access to spawning areas or upstream habitat is now blocked by dams on the large rivers.

Young-of-the-year splittail abundance appears to fluctuate widely from year to year. Young splittail abundance was dramatically reduced during the 1987-1992 drought. However, wet conditions in 1995 resulted in high indices for most measures of young-of-the-year abundance. Abundance was relatively low in 1996 and 1997, but higher than during the drought years. In 1998, young-of-the-year abundance, indexed by the summer townet survey, was again relatively high.

In contrast to young splittail, adult abundance showed no obvious decline during the 1987-1992 drought. Adult population variation is moderated by the species' long life span and multiple year classes. Factors affecting abundance of young splittail include: variation in flooding of terrestrial areas which provide spawning and rearing habitat; changed estuarine hydraulics, especially reduced outflow; modification of spawning habitat; climatic variation; toxic substances; introduced species; predation; and exploitation.

The Sacramento splittail was listed as threatened under the ESA by the USFWS on February 8, 1999.

j. White Catfish. The white catfish was introduced into the Bay/Delta Estuary in 1874 and rapidly increased in abundance. In recent years, the white catfish has supported an important sport fishery. In the Estuary, they are most abundant in areas of slow currents and dead-end sloughs. White catfish, which can live in salinities as high as 11 to 12 ppt, are the only catfish common in Suisun Bay.

k. Largemouth Bass. Largemouth bass, also know as black bass, were first introduced into California in 1874 and have spread to suitable habitat throughout the state. These bass are perhaps the most sought after warmwater gamefish in California. Many California reservoirs and farm ponds provide excellent bass fishing with sizable populations of large, fast-growing fish. One of the factors that influences bass populations in reservoirs, by influencing food availability and spawning success, is the manipulation of water levels for water supply or hydropower production.

The largemouth bass are found in warm, quiet water with low turbidities and aquatic plants such as farm ponds, lakes, reservoirs, sloughs and river backwaters. Adult bass remain close to shore and usually are abundant in water 1 to 3 meters deep near submerged rocks or branches. Young-of-the-year bass also stay close to shore in schools but swim about in the open.

Largemouth bass spawn for the first time during their second or third spring, when they are approximately 180-210 mm. The first notable spawning activity is nest building by males, which starts when water temperatures reach 14-16EC, usually in April. Spawning activity will often continue through June, at temperatures up to 24EC. Nests are generally shallow depressions fanned by the males in sand, gravel or debris-littered bottoms at depths of 1 to 2 m. Rising waters in reservoirs may cause active nests to be located as deep as 4 to 5 m. The eggs adhere to the nest substrate and hatch in two to five days. The sac fry then usually spend five to eight days in the nest or its vicinity.

For the first month or two after hatching, the fry feed mainly on rotifers and small crustaceans, but by the time they are 50 to 60 mm in length they feed largely on aquatic insects and fish fry, including those of their own species. Once largemouth bass exceed 100-125 mm in length, they feed principally on fish, however they also consume crayfish, tadpoles and frogs and prey preferences can vary from year to year.

3. Recreation

Lakes and rivers have always been a primary focus for outdoor recreation activities. Early development of recreational opportunities occurred incidentally at natural water bodies, streams, and rivers. After World War II, outdoor recreation gained in popularity with a rapidly growing population. Water-based recreation has become an integral part of meeting society's recreational needs.

The construction of large reservoirs and the alteration of major rivers have shaped recreation opportunities in the Central Valley. Public water supply projects, such as the CVP, SWP, and local developments, have helped to provide additional recreational opportunities throughout the State. The reservoirs have created extensive flatwater recreation opportunities. At the same time, recreation activities on the lower rivers have been affected as flows, water temperatures, and fisheries have been altered by the placement of dams, the operation of the reservoirs, and the diversion of water from the river system.

Many outdoor recreation activities are water-dependent or water-enhanced. Water-dependent activities include boating, fishing, and swimming; water-enhanced activities include camping, picnicking, hunting, and wildlife observation. Swimming, fishing, and boating are popular activities at California's reservoirs. Recreation facilities such as beaches, boat ramps, trails, restrooms, and access roads add to the quality and safety of the recreation experience. Picnic and camping facilities are often developed at reservoirs to meet public demand. The way that a reservoir is operated and water levels are managed directly affects the quality and economic value of recreational and other contingent activities.

Recreational activity and resources generally do not consume significant amounts of water. Although some water developments were designed and constructed primarily to provide recreation, most water-related recreational facilities are located on streams and reservoirs which are operated for other purposes. In some cases, minimum reservoir releases may be imposed to maintain recreation activities downstream, or the drawdown of a reservoir may be limited during the recreation season.

Reservoir operations for water supply are usually adequate to support established recreation activities, particularly when precipitation and surface runoff are near normal. Changes in operation, because of drought or excessive demands, can reduce recreational opportunities and the associated benefits. In general, reservoir recreation benefits decrease as receding water levels reduce water surface areas, make boat ramps less accessible, and leave recreation facilities farther from shorelines.

Riverine environments can offer recreation opportunities similar to those available at the large water surface impoundments, including boating, fishing, swimming, and related activities. In addition, rivers and streams offer white-water sports, such as rafting, kayaking, and canoeing, and certain fishing opportunities not found in reservoirs, particularly for anadromous fish.

Many streams are unimpaired by water development facilities, such as many of those listed under the State or federal Wild and Scenic Rivers Acts. These streams offer seasonal recreational opportunities in natural settings. Other streams, such as those controlled by reservoir releases, offer opportunities to enhance downstream flows that can benefit recreation values. Streams that would naturally run only intermittently, for example, can have year-round flows following reservoir construction and operation. This kind of conversion can develop new fisheries, add to recreational-area attractiveness, and enhance wildlife habitat. Regulation of larger streams and rivers can support white-water sports for a longer season or increase the diversity of available activities.

Hydroelectric generating facilities can have varying impacts on both reservoir and river recreation depending on whether the operation is constant or subject to peaking. As with water supply releases, increased stream flows from power generation provide recreation that to some degree offset the effects of diminished reservoir storage. In some cases a hydropower development can completely change river recreation benefits. For example, peak releases from the North Fork Stanislaus River project greatly increased white-water rafting but reduced opportunities for swimming in the summer.

Many wildlife refuges in California owe their existence to imported water which supports large populations of migratory waterfowl, upland game and other wildlife. Wetland habitat at refuges and at private hunting clubs is integral to the maintenance of seasonal waterfowl populations along the Pacific Flyway as well as resident game populations. Historically, recreation values associated with such wildlife have focused primarily on hunting. More recently, bird watching has been identified as one of the fastest growing recreational activities in the nation.

The regional descriptions of the environmental setting which follow include a section which describes the water related recreation areas and opportunities in those regions. The recreation areas that would most likely be affected, directly or indirectly, by the SWRCB action are located primarily in the Sacramento River Basin, San Joaquin River Basin, and the Sacramento-San Joaquin Delta, and include:

- reservoirs owned and operated by the CVP, SWP, or local water agencies;
- rivers and streams directly dependent on downstream flows controlled by these reservoirs or otherwise potentially affected by the water rights decision;
- national wildlife refuges (NWRs) or state wildlife management areas (WMAs) that receive surface water diversions; and,
- other facilities that provide limited recreation, such as aqueducts, canals, and private hunting clubs that receive surface water diversions.

B. TRINITY RIVER BASIN

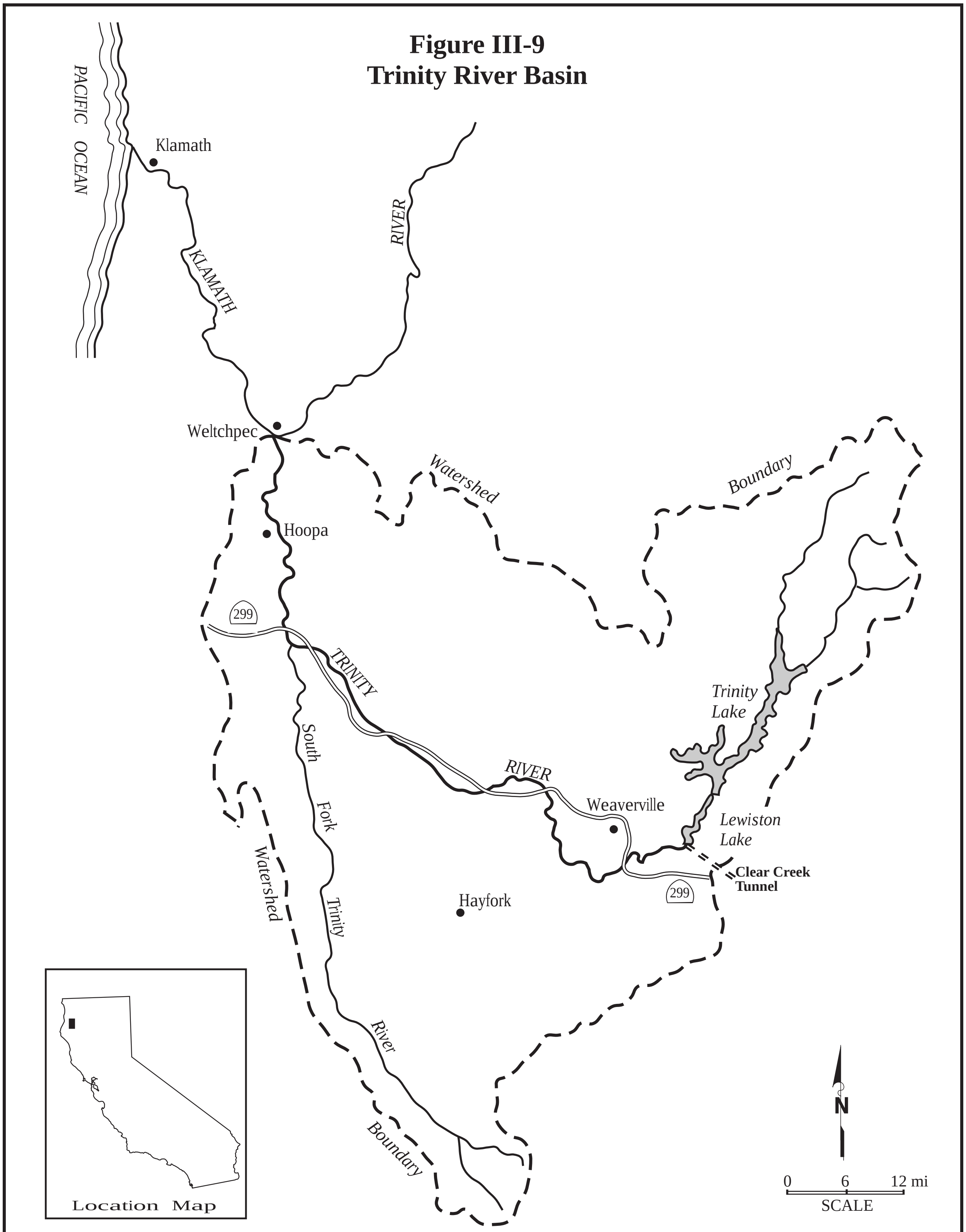
The Trinity River drains a watershed of approximately 3,000 square miles; about one-quarter of which is above Lewiston Dam. The terrain is predominantly mountainous and forested, with little available farming area. Elevations in the basin range from more than 9,000 feet above sea level in the headwaters area to less than 300 feet at the confluence with the Klamath River. Figure III-9 shows the Trinity River Basin.

The Trinity River is the largest tributary to the Klamath River. It consists primarily of the mainstem, and the north and south forks. The mainstem Trinity River originates approximately 20 miles southwest of Mount Shasta in the canyons bordered by the Scott Mountains, the Eddy Mountains, and the Salmon-Trinity Alps. Trinity and Lewiston dams regulate Trinity River flows beyond approximately River Mile 112. The mainstem flows a total of 170 miles west from its origins to the Klamath River at Weitchpec, which is located 43.5 miles upstream from the Pacific Ocean. Major tributaries to the Trinity River include Coffee Creek, Canyon Creek, North Fork, Weaver Creek, New River and South Fork. Hayfork Creek is the major tributary of South Fork.

Urban development within the Trinity River Basin is primarily limited to the communities of Weaverville, Hayfork, Lewiston, Junction City, and Willow Creek. Access through the Basin is provided by State Highways 299, which follows the river from Junction City to Willow Creek, and by State Highway 96 from Willow Creek to Weitchpec. Several small communities have sprung up along State Highway 299 on shallow terrain adjacent to the river. The majority of lands directly adjacent to the river are managed by either the U.S. Forest Service (USFS) or the U.S. Bureau of Land Management (BLM).

The Hoopa Indian Reservation is located north of Willow Creek and encompasses approximately 140 square miles on either side of the Trinity River and State Highway 96 between Willow Creek and the confluence of the Trinity and Klamath rivers near Weitchpec. The Yurok Indian Reservation, which is located within the lower Klamath Valley, extends from the northern boundary of the Hoopa Reservation, along the Klamath River and State Highway 169, to the Pacific Ocean near Requa.

Figure III-9
Trinity River Basin



The climate of the Trinity River drainage is characterized by moderate temperatures and annual precipitation ranging from 35 inches along the Trinity River to over 70 inches at higher elevations. Most precipitation occurs during winter months, much of which occurs as snow at elevations 4,000 feet and above. Average temperatures at Weaverville range from 37°F in January to 71°F in July. Summer air temperatures occasionally exceed 100°F in some areas. The Trinity River Act of 1955 authorized the construction of the Trinity River Division of the CVP. The USBR constructed the Trinity River Division in the early 1960's to augment CVP water supplies. The facilities of the Trinity River Division store and divert water from the Trinity River for export to the Sacramento River Basin. The CVP uses the Trinity River water to meet agricultural and urban water demand in the Sacramento and San Joaquin valleys, and to generate hydroelectric power.

Trinity Lake (formerly Clair Engle Lake), impounded by Trinity Dam, stores over 2.4 million acre-feet of winter runoff from the Trinity River. Immediately downstream, Lewiston Dam and Reservoir regulate flows in the Trinity River and provide a forebay for the diversion of flows from the Trinity River Basin, through the Clear Creek Tunnel to Whiskeytown Reservoir in the Sacramento River Basin.

Water diverted through the 10.7-mile Clear Creek Tunnel enters Whiskeytown Reservoir through the Judge Francis Carr Powerhouse. Whiskeytown Reservoir, located on Clear Creek, has a storage capacity of about 240,000 acre-feet. Flows on Clear Creek vary depending on the year type, with mean annual flows of 265,000 acre-feet. Releases are made from Whiskeytown to Clear Creek (42,000 acre-feet per year) and Clear Creek South Unit (15,000 acre-feet per year) to satisfy fish flow requirements and water rights. The remaining water supply from Clear Creek, along with the Trinity exports, is diverted from Whiskeytown through the Spring Creek Tunnel to Keswick Reservoir on the Sacramento River. Power is generated at Trinity, Lewiston, Spring Creek, Judge Francis Carr, and Keswick powerplants.

The Trinity River Division of the CVP was completed in 1963, and exports from the Trinity River began in May of that year. The mean annual inflow to Trinity Reservoir is about 1.1 MAF, with annual flows ranging from approximately 0.27 to 2.7 MAF. Long-term average annual exports are about 881,000 acre-feet. From 1980 through 1992, these exports have averaged 864,000 acre-feet annually. There are no in-basin deliveries of water from the CVP's Trinity River Division. However, Humboldt County and other downstream users have a claim to 50,000 acre-feet under area-of-origin rights that may be requested in the future.

The export of water from the Trinity Basin resulted in reduced stream flows, sedimentation, and vegetation encroachment in the Trinity River, which has adversely impacted the fisheries. Originally, releases from the Trinity and Lewiston dams to the Trinity Rivers were approximately 120,000 AF per year. As much as 90 percent of the Trinity River annual flows have been diverted through the Clear Creek Tunnel. The 1955 Trinity River Act contains a clause that states that the Interior Secretary is "authorized and directed to adopt appropriate measures to insure the preservation and propagation of fish and wildlife." In the late 1970's, the USBR increased the releases to vary between 270,000 and 340,000 acre-feet per year in an effort to reverse salmon declines.

The Interior Department has a trust obligation to the Hoopa Valley and Yurok tribes to protect their federally reserved fishing rights, which includes providing adequate streamflow to protect and restore Trinity River fish populations for tribal harvest. The tribes rely on the harvest of salmonids for subsistence and ceremonial and commercial needs. In 1991, the Secretary of the Interior responded to a request for increased flows from the Hoopa Valley and Yurok tribes and increased the minimum flows to 340,000 acre-feet per year.

A major study is under way to establish the optimum flow schedule for fisheries on the Trinity River. A 1981 Interior Secretary's Decision directed the USFWS to conduct a 12-year Trinity River Flow Evaluation Study to evaluate the effects on fish habitat of adjusting the flows. Section 3406(b)(23) of the Central Valley Project Improvement Act (P.L. 102575) allocated a minimum of 340,000 acre-feet per year for the purposes of fishery restoration, propagation, and maintenance, and further required that the Trinity River Flow Evaluation Study be completed in a manner which ensures the development of recommendations for the restoration and maintenance of the Trinity River fishery.

The Draft Trinity River Flow Evaluation, released in January 1998, contains daily flow recommendations for the Trinity River, which range, depending on water year type, from 300 cfs to 10,564 cfs. If these daily flow recommendations are adopted, releases from Trinity Lake into the Trinity River will range from 368,621 acre feet in a critically dry year to 815,226 acre feet in an extremely wet year, excluding unscheduled releases associated with large storm events.

The USFWS, USBR, the Hoopa Valley Tribe, and Trinity County are preparing an EIR/EIS on Trinity River Mainstem Fishery Restoration (Trinity EIR/EIS), which will evaluate a range of alternatives for restoration of the Trinity River fisheries, including the recommended flows in the Flow Evaluation Study. The Trinity EIR/EIS will also evaluate economic and other impacts of the restoration alternatives on the Central Valley, Trinity, and lower Klamath Basin regions.

C. SACRAMENTO RIVER BASIN

1. Geography and Climate

The Sacramento River Basin contains the entire drainage area of the Sacramento River and its tributaries and extends almost 300 miles from Collinsville in the Sacramento-San Joaquin Delta to the Oregon border. The crests of the Sierra Nevada and Cascade ranges form the region's eastern and northern boundaries. The American River watershed and the northern Delta form the southern limits, and the crest of the Coast Ranges defines the western boundary of the region. Mount Shasta rises 14,162 feet above sea level in the north and the lower Sacramento Valley drops to near sea level. The Sacramento River meanders from north to south through the broad valley in the central part of the region. The region encompasses 17 percent of the State's total land area. Figure III-10 shows the Sacramento River Basin.

The climate varies considerably in the region. However, three distinct climate patterns can be defined: (1) The northernmost area, mainly high desert plateau, is characterized by cold, snowy winters with only moderate rainfall, and hot, dry summers. This area depends on melting snowpack to provide a summertime water supply. Average annual precipitation in the area ranges from 10 to 20 inches. (2) Other mountainous parts in the north and the east have cold, wet winters with major amounts of snow providing considerable runoff for the summer water supply. These higher mountainous areas may receive precipitation during any month of the year, with annual precipitation totals from about 20 to over 80 inches. Summers are usually mild in the mountains. (3) The Sacramento Valley, the south-central part of the region, has mild winters with less precipitation. Precipitation usually occurs from October through May. Summers in the valley are hot with virtually no precipitation from June to September. Sacramento's average annual precipitation is 18 inches.

2. Population

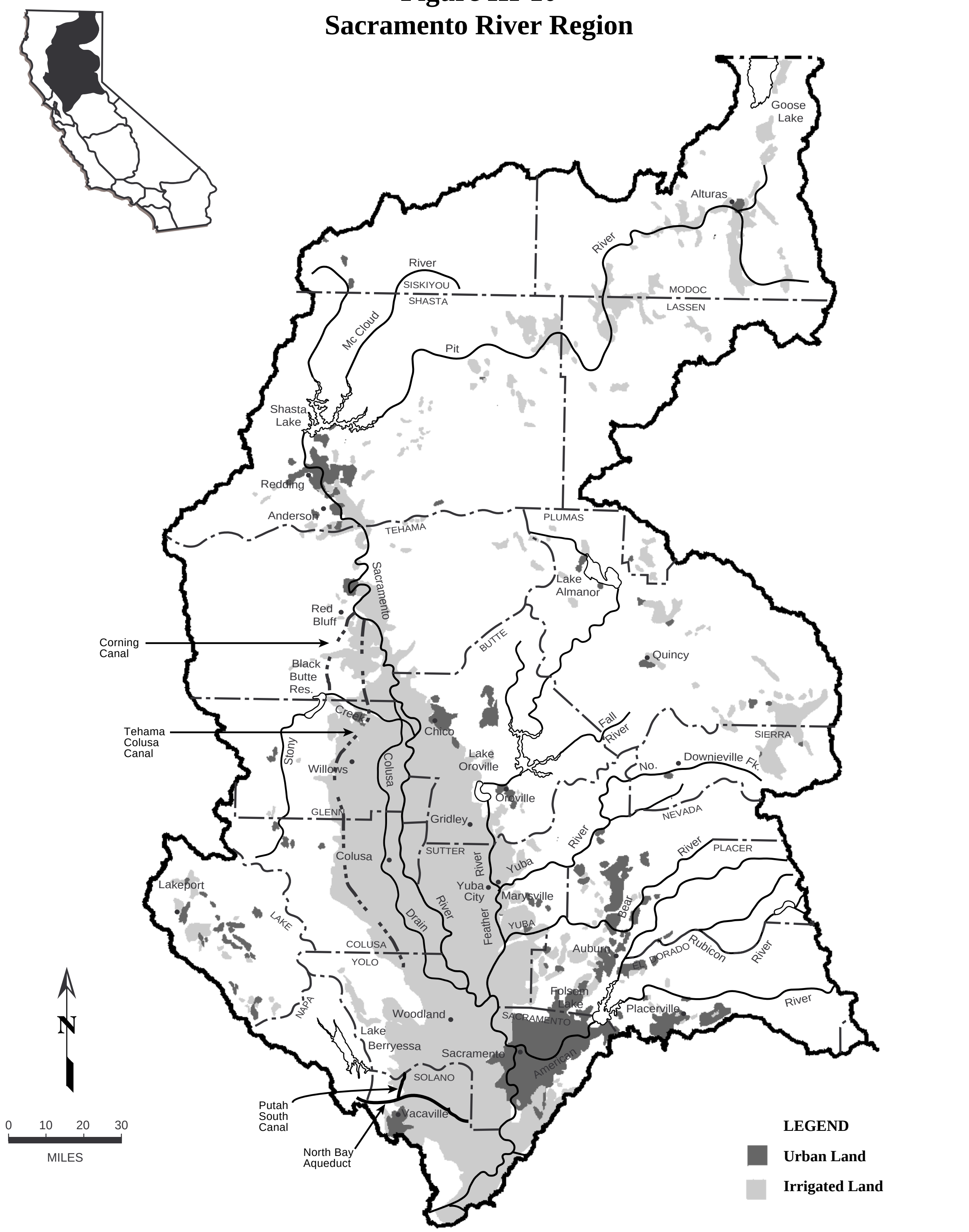
With a population of over 2.2 million, the 1990 census showed 535,000 more people in the Sacramento River Basin than in 1980, a 32-percent increase. Immigration from other parts of California played a big role in the increase. The fastest growing town was Loomis, a foothill community about 25 miles northeast of Sacramento, where there was a 344-percent increase between 1980 and 1990. The City of Sacramento had the greatest number of new residents: more than 93,600 additional people. More than half of the region's population lives in the greater metropolitan Sacramento area. Other fast-growing communities include Vacaville, Dixon, Redding, Chico, and various Sierra Nevada foothill towns.

3. Land Use and Economy

The economy of the Sacramento River Basin is based primarily on irrigated agriculture and livestock production. Related industries include food packing and processing, agricultural services and the farm equipment industry. Another important segment of the economy in the Sacramento River Basin consists of military and other federal government stablishments, the State government, and the aerospace industry. Emerging industries include electronics, computers and other high technology industries. Lumber industries are centered in the Sierra Nevada, Cascade Range, Modoc Plateau, and a portion of the Coast Ranges. Other natural resource industries are engaged in extraction or mining and production of natural gas, clay, limestone, sand, gravel, and other minerals. While agriculture is the largest land use it does not provide the most jobs. The largest proportions of wage and salary jobs are in the service, wholesale and retail trade, government and manufacturing sectors, respectively.

A wide variety of crops is grown in the Sacramento River Basin. The region produces a significant amount of the overall agricultural tonnage in California, especially rice, grain, tomatoes, field crops, fruit, and nuts. Because of comparatively mild weather and good soil, some double-cropping occurs in the region. The largest of any single crop is rice, which represents about 23 percent of the total.

Figure III-10
Sacramento River Region



Source: DWR, Bulletin 160-93 (1994)

The Sacramento River Basin supports about 2,145,000 acres of irrigated agriculture (22 percent of State total). About 1,847,000 acres are irrigated on the valley floor. The surrounding mountain valleys within the region add 298,000 irrigated acres (primarily pasture and alfalfa) to the region's total. Crop statistics show that irrigated agricultural acreage in the region peaked during the 1980s and has since declined. The main reason for this decline is the conversion of irrigated agricultural lands to urban development. The comparison of 1980 and 1990 crop patterns shows that grain, field, rice, and pasture crops decreased by 137,000 acres. On the other hand, orchard, alfalfa, and tomato crops gained a total of 106,000 acres. The net decrease of irrigated crops between 1980 and 1990 was 31,000 acres.

Major urban areas include Sacramento, West Sacramento, Davis, Vacaville, Woodland, Folsom, Roseville, Yuba City, Marysville, Chico, Redding, and Red Bluff. Larger foothill communities include Placerville, Auburn, Grass Valley, Nevada City, and Oroville. Towns and cities that primarily serve the agricultural interests in the upper valley include Williams, Willows, Corning and Colusa. Many small communities exist along the river in the upper valley, such as Tehama, Los Molinos, Hamilton City, Princeton, and Butte City. Along the lower river, major urban development from the City of Sacramento fronts the river, with minor residential and commercial development at Knights Landing, Rio Vista, Isleton, Walnut Grove, Locke, Hood, Clarksburg, and Freeport. Marinas are common along the river in this reach, especially between Clarksburg and just upstream of Discovery Park. Agriculture is the most important segment of the economy for the smaller communities, while manufacturing and services are more important for the economy of the larger towns.

4. Water Supply

The Sacramento River Basin produces about two-thirds of the surface water supply of the Central Valley. Average runoff from the basin is estimated at about 22 MAF per year, which is nearly one-third of the State's total runoff. Average annual water supply for the region is 11.7 MAF, of which surface water provides 50 percent and groundwater provides 22 percent. About 28 percent of the average annual water supply is considered dedicated natural flows which meet the instream flow requirements of the major streams in the basin. Water is both imported into the region and exported from the region.

Clear Creek Tunnel carries about 881,000 acre-feet per year from Lewiston Lake on the Trinity River to Whiskeytown Reservoir. Minor imports to the basin are made from Echo Lake, Sly Park Reservoir, and the Little Truckee River. About 6 MAF per year are exported from the Sacramento River Basin through State, federal and local conveyance facilities.

A number of reservoirs in the region provide water supply, recreation, power, environmental, and flood control benefits. A list of the major reservoirs in the Sacramento River Basin is presented in Table III-8. The area has a total of about 16 MAF of surface storage capacity.

a. Surface Water Hydrology. The major tributaries of the Sacramento River above Shasta Dam are the Pit and McCloud rivers. The Pit River, which is the most extensive tributary to Shasta Reservoir, contributes about 60 percent of the average annual surface inflow to the reservoir. The McCloud River, which originates in southeastern Siskiyou County, contributes about 10 percent of the average annual surface inflow to Shasta Lake. The Sacramento River, which originates as the north, middle, and south forks on the east slopes of the Trinity Divide in Siskiyou County, contributes about 14 percent of the total average annual surface inflow to Shasta Lake. Minor tributaries to the lake provide the remaining inflow.

The approximately 56 miles of the Sacramento River from Keswick Dam to Red Bluff is largely contained by steep hills and bluffs. River flows in the upper part of this reach are highly controlled by releases from Shasta Reservoir, but become more influenced by tributary inflow downstream. Major tributaries to the Sacramento River between Keswick Dam and Red Bluff include Cow, Stillwater, Bear, Battle, Paynes, Cottonwood, and Clear creeks.

The Sacramento River between Red Bluff and Colusa is a meandering stream, migrating through alluvial deposits between widely spaced levees. The Sacramento Canals Unit of the CVP serves over 200,000 acres in the Sacramento Valley in Tehama, Glenn, Colusa, and Yolo counties. This unit consists of the Red Bluff Diversion Dam, Corning Pumping Plant, and several canals including the 122-mile long Tehama-Colusa Canal which terminates in the northern part of Yolo County.

The Glenn Colusa Irrigation District supplies water from the Sacramento River near Hamilton City to about 175,000 acres of land, including 25,000 acres within three federal wildlife refuges. Numerous small diversions along the Sacramento River provide irrigation to riparian lands. The Colusa Basin drainage area is located west of the Sacramento River, extending from Orland to Knights Landing. The basin contains some 350,000 acres of rolling foothills located along the eastern slopes of the Coast Ranges, and about 650,000 acres in the flat agricultural lands of the Sacramento Valley. The area is served by the Colusa Basin Drain, a multi-purpose drain that is used both as an irrigation supply canal and as an agricultural return flow facility. The drain eventually discharges into the Sacramento River through the regulated outfall gates at Knights Landing or, during flood events, into the Yolo Bypass through the Knights Landing Ridge Cut.

In addition to the major reservoirs which provide flood control, the Sacramento basin has more than 2.2 MAF of potential flood control storage consisting of a highly developed system of flood control basins, levees, channels, and bypasses. The basins are composed of a series of natural and man-made bypass overflow areas that act as auxiliary channels to the Sacramento River during floodwater times. The bypass areas are used for agriculture during the summer and fall months, and are valuable wetlands during the flood season.

Table III-8
Major Reservoirs in the Sacramento River Basin

Reservoir Name	Stream	Capacity (TAF)	Owner
McCloud	McCloud River	35.2	PG&E
Iron Canyon	Pit River	24.2	PG&E
Lake Britton	Pit River	40.6	PG&E
Pit No. 6	Pit River	15.9	PG&E
Pit No. 7	Pit River	34.6	PG&E
Shasta	Sacramento River	4,552.0	USBR
Keswick	Sacramento River	23.8	USBR
Whiskeytown	Clear Creek	241.1	USBR
Lake Almanor	Feather River	1,143.8	PG&E
Mountain Meadows	Feather River	23.9	PG&E
Butt Valley	Butt Creek	49.9	PG&E
Bucks Lake	Bucks Creek	105.6	PG&E
Antelope	Indian Creek	22.6	DWR
Frenchman	Little Last Chance Creek	55.5	DWR
Lake Davis	Big Grizzly Creek	84.4	DWR
Little Grass Valley	Feather River	94.7	OWID
Sly Creek	Lost Creek	65.7	OWID
Thermalito	Feather River	81.3	DWR
Oroville	Feather River	3,537.6	DWR
New Bullards Bar	Yuba River	966.1	YCWA
Jackson Meadows	Yuba River	69.2	NID
Bowman Lake	Canyon Creek	68.5	NID
French Lake	Canyon Creek	3.8	NID
Spaulding	Yuba River	135.7	PG&E
Englebright	Yuba River	70.0	USCOE
Scotts Flat	Deer Creek	48.5	NID
Rollins	Bear River	66.0	NID
Camp Far West	Bear River	104.0	SSWD
French Meadows	American River	136.4	PCWA
Hell Hole	Rubicon River	207.6	PCWA
Loon Lake	Gerle River	76.5	SMUD
Slab Creek	American River	21.6	PG&E
Caples Lake	Caples Creek	16.6	PG&E
Union Valley	Silver Creek	277.3	SMUD
Ice House	Silver Creek	46.0	SMUD
Folsom Lake	American River	974.5	USBR
Lake Natoma	American River	9.0	USBR
East Park	Stony Creek	50.9	USBR
Stony Gorge	Stony Creek	50.0	USBR
Black Butte	Stony Creek	143.7	USCOE
Clear Lake	Cache Creek	313.0	YCFC&WCD
Indian Valley	Cache Creek	301.0	YCFC&WCD
Lake Berryessa	Putah Creek	1,600.0	USBR

Source: DWR 1993b

From about Colusa to the Delta, the Sacramento River is regulated by the Sacramento River Flood Control Project which diverts floodwater in the Sacramento River into the Sutter Bypass. The Sutter Bypass runs between the Sacramento and Feather Rivers and receives additional flow from the Feather River. The combined flow enters the Yolo Bypass at Fremont Weir near Verona. American River flood-flows enter the Yolo Bypass through the Sacramento Weir. The Yolo Bypass returns the entire excess flood flow to the Sacramento River, about 10 miles above Collinsville. The system provides flood protection to about 800,000 acres of agricultural lands and many communities, including the cities of Sacramento, Yuba City, and Marysville.

Major streams entering the Sacramento River between Red Bluff and the Delta include Thomes, Elder, Stony, and Putah creeks from the west, and Antelope, Mill, Deer, Big Chico, and Butte creeks and the Feather, Yuba, Bear, and American rivers from the east. Numerous small tributaries drain the low foothills on either side of the valley.

Butte Creek flows southwesterly from the Sierra Nevada into the Sacramento Valley near Chico, then parallels the Sacramento River until it flows into Butte Slough south of Colusa. The lower portion of the Butte Basin is known as the Butte Sink, an important wetland habitat for waterfowl. This area is one of five major flood basins in the Sacramento Valley and often floods in the winter. Flood flows are diverted to the Sutter Bypass and discharged through Sacramento Slough to the Sacramento River just above the confluence of the Feather River.

The Feather River is regulated by Oroville Dam and Reservoir. Electrical power is generated in the Hyatt-Thermalito complex at the base of the dam. Water released through the powerplant enters the Thermalito Diversion Pool created by the Thermalito Diversion Dam, about 4,000 feet downstream from Oroville Dam. From Oroville Dam, the Feather River flows south for 65 miles and empties into the Sacramento River near Verona, about 21 river miles above Sacramento.

Above Oroville Dam, the Feather River drains 3,634 square miles of watershed with an average annual runoff of 4.2 MAF. Three small reservoirs (Davis, Frenchman, and Antelope) on separate forks of the Feather River provide local irrigation, recreation, and incidental flood control. In addition, PG&E operates Lake Almanor and other storage and diversion facilities in the upper Feather basin to generate hydroelectric power. Below Oroville Dam two large tributaries, the Yuba and Bear rivers, contribute 1.5 MAF annually to the watershed.

The Yuba River, on the western slope of the Sierra Nevada mountains, has a watershed of about 1,300 square miles. Flows in the North Yuba River are impounded in New Bullards Bar Reservoir about 29 miles northeast of Marysville. Releases from New Bullards Bar Reservoir join the Middle Yuba River and flow into Englebright Reservoir along with flows from the South Yuba River. Releases from Englebright Dam flow westerly to join the Feather River at Marysville. About mid-way, Daguerra Point Dam serves both as a barrier to impair downstream movement of mining debris and as the point of diversion for the major water irrigation districts utilizing Yuba River flows. The facilities are operated for power production, fisheries maintenance, water supply, recreation, and flood control.

The Bear River drains the area south of the Yuba River and north of the American River Basins. Flows from the Bear River are conserved in Rollins and Camp Far West reservoirs. Average unimpaired runoff in the basin is about 300,000 acre-feet per year. The Bear River joins the Feather River just above Nicolaus.

The American River drains a 1,921 square mile area in the north-central portion of the Sierra Nevada, with mean annual unimpaired runoff estimated at 2.6 MAF. CVP facilities on the American River include Folsom Dam and Reservoir and Nimbus Dam which impounds Lake Natoma as an afterbay for Folsom Dam. These facilities regulate river flow for irrigation, power, flood control, municipal and industrial use, and other purposes. The American River joins the Sacramento River about 25 miles downstream from Nimbus Dam.

b. Surface Water Quality. Surface waters in the Sacramento River are of excellent mineral quality and suitable for most uses from the headwaters to Red Bluff. From Red Bluff to the Delta, the Sacramento River is of generally good quality although periodic degradation of water quality occurs. The principle surface water quality problems in the Sacramento River Basin include contaminated runoff from mines and mine tailings, warm water temperatures, discharges from industrial and municipal developments, agricultural drainage and saline water intrusion.

Drainage from abandoned mines and tailings has occasionally caused severe local fish kills in the upper watershed and/or adversely affected animals and plants on which fish feed. A particular problem is the Iron Mountain region a few miles northwest of Redding. This region produces acidic runoff containing high concentrations of copper, zinc, iron, aluminum and other toxic salts leached from tailings of both active and abandoned mines.

Warm water temperatures are a problem in both Shasta Lake and the Sacramento River. Shasta Lake thermally stratifies, producing significant differences between surface and bottom water temperatures. During summer thermal stratification, minimum dissolved oxygen levels have been found near the thermocline as low as 3 to 6 parts per million (ppm). Elevated temperatures in the upper river are a primary factor limiting winter-run chinook salmon survival.

Waste discharges originating from industrial and municipal developments enter the Sacramento River along the entire length from Keswick to Red Bluff. Lumber by-product industries, cities and towns, light industries, food product plants and a considerable volume of irrigation return flow all contribute a significant waste load to the Sacramento River. Concentrated effluent is discharged to the Sacramento River by the cities of Redding, Red Bluff, Chico, Sacramento, and West Sacramento. Additional discharges to the Sacramento River system are made from the wastewater treatment plants serving Roseville, Vacaville, Davis, Oroville and other communities.

Dioxins, a closely related group of highly toxic compounds, are discharged with mill waste into the Sacramento River near Anderson. Consequently, the Department of Health Services has issued an advisory not to eat resident fish from the Sacramento River between Keswick and Red Bluff. The

Central Valley RWQCB has ordered the paper company to reduce dioxins concentrations in the discharge.

Agricultural drainage contributes to lower water quality during low flow periods in the Sacramento River and the lower reaches of the major tributaries. Agricultural drainage contributes substantial mineral and nutrient loads to the Sacramento River and increases turbidity.

In the lower Sacramento River, water quality is affected by intrusion of saline water from the San Francisco Bay/Estuary. The lower the flows in the Sacramento River the farther inland tidally driven saline water from the estuary can intrude. Saline intrusion is of increasing concern as consumptive uses of freshwater continue to increase statewide.

The upper reaches of major tributaries, including the Feather, Yuba, and American rivers, all have excellent water quality characteristics. Downstream from storage reservoirs, however, some degradation occurs due to various discharges. Water quality concerns in tributaries include: low dissolved oxygen levels in Butte Slough, Sutter Bypass, and Colusa Basin Drain; high water temperatures below diversion structures on Butte Creek; concentrations of minor elements (chromium, copper, iron, lead, manganese, selenium, and zinc) that exceed beneficial use criteria in the Sutter Bypass; and pesticide residues in the Sutter and Yolo bypasses and Colusa Basin Drain. Additional concern exists for effects of tributary discharges to the Sacramento River, including elevated temperature, dissolved solids, minor elements, pesticides, and turbidity, especially from the Sutter and Yolo bypasses and Colusa Basin Drain. Downstream water temperature also is a concern on the Yuba and American rivers.

c. Groundwater Hydrology. Groundwater provides about 2.5 MAF of the average annual water supply for the Sacramento River Basin. Groundwater is found in both the alluvial basins and in the hard rock areas. Although groundwater is a lesser source of water in the foothills, it plays an important role in meeting the needs of many individuals. Groundwater within the mountain counties exists mostly in fractured rock. Yields in most of the upland hard rock areas are fairly low but can support most domestic activities or livestock. Some wells in the volcanic hard rock areas of the upper Sacramento River and Pit River watersheds yield large amounts of water.

The northern third of the Central Valley regional aquifer system is located in the Sacramento River Basin. This part of the aquifer system extends from north of Redding to the Delta. The DWR has subdivided this region into the Sacramento Valley basin and the Redding Basin, together covering over 5,500 square-miles. The Red Bluff Arch separates the groundwater basins. Other smaller subbasins exist in the Sacramento River Basin above the valley floor.

Depth to the base of fresh water ranges from 1,000 feet in the Orland area to 3,000 feet in the Sacramento area. Throughout the region, the aquifer system is unconfined to semiconfined with no extensive confining clay layers identified in the subsurface. Well yields in the alluvial basins vary from less than 100 to over 4,000 gpm. The aquifer system is recharged primarily through seepage from rivers, streams, and conveyance facilities, subsurface inflow along basin boundaries, and through deep percolation of rainfall and applied irrigation water. Discharge occurs through pumping and seepage to surface streams which provides much of the summer baseflow in the tributary streams to the Sacramento River.

Usable storage capacity has been estimated at 40 million acre-feet based on aquifer properties, water quality and economic considerations such as drilling and pumping costs. In the California Water Plan Update (DWR Bulletin 160-93) the perennial yield of the aquifer system is estimated to be 2.4 million acre-feet per year. Overdraft conditions occur locally as in the Sacramento County area where the water table has fallen to more than 40 feet below sea level. Local overdraft conditions also are responsible for land subsidence in the basin. The main area where land subsidence has been documented is between the towns of Davis and Zamora in the southwestern part of the basin.

High water tables contribute to subsurface drainage problems in several areas of the Sacramento River Basin including portions of Colusa County, particularly along the Sacramento River. The subsurface drainage functions of the Colusa Basin Drain and other local drainage facilities are periodically impaired in this area. Seepage from the Sacramento River helps to maintain high groundwater levels in many reaches. During extended periods of high streamflow, seepage can damage crop roots and prevent farm equipment from entering fields.

d. Groundwater Quality. Groundwater quality in the Sacramento River Basin is generally excellent; however, there are areas with localized groundwater contamination or pollution. Although total dissolved solids (TDS) in groundwater have increased since the 1950s, TDS concentrations generally do not exceed 500 mg/l in the region. Boron is an element toxic to most crops at concentrations above 4 mg/l and is toxic to some crops at concentrations as low as 0.75 mg/l. A large area of high boron concentration occurs in the southwestern part of the Sacramento River Basin extending south from Arbuckle to Rio Vista. The USEPA primary drinking water standard for nitrate concentration is 10-mg/l nitrate as N. Maximum nitrate concentrations greater than 10 mg/l have been reported throughout the region, however, concentrations exceeding 30 mg/l are rare and localized. Municipal use of groundwater as drinking water is impaired due to nitrate concentrations in the Chico area.

5. Water Use

The 1990 level annual net water use in the Sacramento River Basin is 11.7 MAF. Agricultural uses make up 58 percent of the net water demand (6.8 MAF), and environmental uses (which include instream flow requirements and wetlands) make up 32 percent (3.7 MAF). Urban water use for 1990 was 744,000 acre-feet (6 percent of total net water use) and conveyance facility losses, recreation uses, and energy production accounted for about 4 percent of the total net use for the region.

Some of the larger cities in the region take a substantial portion of their water supplies from the major rivers, but throughout most of the region, groundwater is the principal source for urban use. About 56 percent of all urban water use is residential and an average of 75 percent of all residential water use is for landscaping. The high water-using industries of the region are closely tied to agriculture and forestry. Tomato and stone fruit processing, sugar mills, paper pulp, and lumber mills consume large amounts of water.

The average annual applied water demand for agricultural uses in the region in 1990 was over 7.8 MAF. On-farm irrigation efficiencies vary widely, depending on individual crops, soils, irrigation methods, system reuse, water scarcity, and irrigation costs. Areas depending on groundwater or limited surface water tend to be very efficient. Others with higher priority to dependable supplies are often less conservative in their water usage, but excess water applied generally returns to the supply system through drainage canals, or recharges groundwater. Basin efficiency is usually very good because downstream users recycle the return flows which, in many places, constitute the only water source.

6. Vegetation

The Sacramento River Basin contains a variety of vegetative communities occupying nearly 6.8 million acres out of a total land area of 9.2 million acres. The natural communities include mixed conifer forest, montane hardwood forest, montane riparian, foothill woodland, valley oak woodland, mixed chaparral, valley and foothill riparian, valley grassland, and freshwater emergent wetland. Each community can be subdivided into more highly defined groups, but this level of distinction was not considered necessary for this document except for the mention of sensitive communities (as defined by the DFG's Natural Diversity Database). These communities consist of both native and nonnative species. Some have been heavily disturbed by activities such as agriculture and urban development. Within these communities there are approximately 30 endangered, threatened, or otherwise sensitive plant species. The largest number of special-status plant species in the region occurs in grassland which includes vernal pools. The second largest number of special-status plant species is found in mixed conifer forest. The majority of special-status wildlife species are found in the grasslands, fresh emergent wetlands and various riparian communities.

One type of sensitive community found in association with grasslands in the Sacramento and San Joaquin valleys and Southern California is the vernal pool -- low herbaceous communities dominated by annual herbs and grasses. They form over hardpan, claypan, basalt, and volcanic mudflow soils. Winter precipitation fills the pools, stimulating vegetative growth in the pool and around the margins. Some of this vegetation is endemic to the vernal pool habitat, having evolved to survive in the extreme and rapidly changing hydrologic conditions. By late spring, most pools have evaporated. In the Sacramento Valley, four types of vernal pools can occur: northern hardpan, northern claypan, northern basalt flow, and northern volcanic mudflow. Other sensitive communities of the Sacramento River Basin that can be generally categorized as valley grassland include valley needlegrass grassland, serpentine bunchgrass, wildflower fields, freshwater seeps, and alkali playas.

Sensitive habitats in the Sacramento River Basin that can be grouped into the valley and foothill riparian community type include: great valley-valley oak riparian forest, great valley cottonwood riparian forest, great valley mixed riparian forest, white alder riparian forest, great valley willow scrub, buttonbush scrub, and elderberry savanna. Three sensitive freshwater emergent wetland communities occur in the Sacramento River Basin, including cismontane alkali marsh, coastal and valley freshwater marsh, and vernal marsh. Sensitive mixed chaparral communities include Gabroic northern mixed chaparral, serpentine chaparral, and Ione chaparral.

The foothill woodland vegetation community type occurs in the foothills and valley borders, usually between 500 and 3,000 feet in elevation. It is typically dominated by one or more species of oaks in association with pines, California buckeye, *Ceanothus* species, manzanita, and annual grasses. Two subsets of this community type are blue oak woodland, found on the lower slopes of the foothills surrounding the Central Valley, and blue oak-foothill pine woodland, found at slightly higher elevation. Throughout California over the past 25 years, oak woodlands (both foothill and valley) have been lost at a rate of almost 14,000 acres annually to residential and commercial development.

Twelve plant species found in the Sacramento River Basin are listed by either the State or Federal Government as threatened, endangered, or rare. One other has been proposed for listing. Table III-9 lists the sensitive plant species found in the Sacramento River Basin.

7. Fish

The Sacramento River and tributaries between Keswick Dam and the Delta provide important habitats for a diverse assemblage of fish, both anadromous and resident species. The region contains a variety of native and introduced fish species, including both coldwater and warmwater fishes. Although the basin has been greatly modified by water development projects, many rivers and lakes still support excellent sport fisheries and runs of anadromous fish. Hatcheries on several rivers supplement the natural fish populations. Table III-10 lists the more commonly recognized fish species found in the Sacramento River and tributaries. Table III-11 lists the sensitive fish species found in the Sacramento River Basin.

Keswick Dam on the main stem and other dams on the tributaries form complete barriers to upstream migration of fish, primarily chinook salmon and steelhead. Migratory fish trapping facilities at Keswick Dam are operated in conjunction with the Coleman National Fish Hatchery on Battle Creek, 25 miles downstream. The Sacramento River upstream from Colusa produces about half of the Central Valley chinook salmon population. About one third of the river's naturally spawning salmon (mainly the fall run) spawn directly in the reach from Colusa to Red Bluff (mainly above Chico Landing), and all salmon use the river for rearing and migration.

Oroville Dam on the Feather River has made spawning areas upstream of the dam inaccessible for salmon and steelhead. To compensate for this loss, the DWR built the Feather River Fish Hatchery downstream from Oroville Dam. Anadromous fish cannot pass Nimbus Dam on the American River. Thus, the Nimbus Salmon and Steelhead Hatchery was constructed on the downstream side of Nimbus Dam. The following discussion provides a more detailed regional description of the fisheries found in the Sacramento River Basin.

Table III-9
Sensitive Plant Species in the Sacramento River Basin

Scientific Name	Common Name	Status State	Status CNPS	Status Federal
Brodiaea coronaria ssp. rosea	Indian Valley brodiaea	SE	1B	FSC
Calystegia stebbinsii	Stebbin's morning-glory			FE
Ceanothus roderickii	Pine Hill ceanothus			FE
Chamaesyce hooveri	Hoover's spurge		1B	FT
Cordylanthus palmatus	Plamate-bracted bird's-beak	SE	1B	FE
Eryngium constancei	Loch Lomond coyote-thistle			FE
Fremontodendron californicum ssp. decumbens	Pine Hill flannelbush	FE		
Galium californicum ssp. sierrae	El Dorado bedstraw			FE
Gratiola heterosepala	Boggs Lake hedge hyssop	SE	1B	
Limnanthes floccosa ssp. californica	Butte County meadowfoam	SE	1B	FE
Lupinus milo-bakeri	Milo Baker's lupine	ST	1B	FSC
Navarretia leucocephala ssp. Pauciflora	Few-flowered navarretia			FE
Navarretia leucocephala ssp. Plieantha	Many-flowered navarretia			FE
Neostapfia colusana	Colusa grass	SE	1B	FT
Orcuttia pilosa	Hairy Orcutt grass	SE	1B	FE
Orcuttia tenuis	Slender Orcutt grass	SE	1B	FT
Orcuttia viscida	Sacramento Orcutt grass	SE	1B	FE
Parvisedum leiocarpum	Lake County stonecrop			FE
Pseudobahia bahiifolia	Hartweg's golden sunburst	SE	1B	FE
Senecio layneae	Layne's butterweed			FT
Tuctoria greenei	Greene's tuctoria	SR	1B	FE
Tuctoria mucronata	Crampton's tuctoria	SE	1B	FE

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
CNPS: (California Native Plant Society) 1A=presumed extinct in California; 1B=rare,threatened, or endangered in California and elsewhere; 2=rare,threatened,or endangered in California but more common elsewhere; 3=need more information; 4=distribution limited (a watchlist).
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

TABLE III-10
Common Fish Species in the Sacramento River and Tributaries.

ANADROMOUS	RESIDENT		
	Warmwater Game	Coldwater Game	Non-game
Chinook salmon (four races)	largemouth bass	rainbow trout	Sacramento squawfish
Steelhead trout	smallmouth bass	brown trout	Sacramento sucker
Striped bass	spotted bass		golden shriner
American Shad	white crappie		tule perch
green sturgeon	black crappie		carp
white sturgeon	channel catfish		threadfin shad
Pacific lamprey	white catfish		hardhead
	brown bullhead		
	yellow bullhead		
	bluegill		
	green sunfish		

Table III-11
Sensitive Fish Species in the Sacramento River Basin

Scientific Name	Common Name	Status: State	Status: Federal
Acipenser medirostris	Green Sturgeon	CSC	FSC
Catastomus microps	Modoc sucker	SE	FE
Cottus asperrimus	Rough sculpin	ST	FSC
Gila bicolor thalassina	Goose Lake tui chub	CSC	
Hypomesus transpacificus	Delta smelt	ST	FT
Lampetra tridentata ssp.	Goose Lake Lamprey	CSC	
Lavinia symmetricus mitrulus	Pit roach	CSC	
Oncorhynchus tshawytscha	Fall-run chinook salmon, Central Valley, CA ESU		C
Oncorhynchus tshawytscha	Late fall-run chinook salmon, Central Valley, CA ESU	CSC	C
Oncorhynchus tshawytscha	Spring-run chinook salmon	ST	FT
Oncorhynchus tshawytscha	Winter-run chinook salmon	SE	FE
Oncorhynchus mykiss ssp.	Goose Lake redband trout	CSC	FSC
Oncorhynchus mykiss ssp.	McCloud River redband trout	CSC	C
Oncorhynchus mykiss	Steelhead, Central Valley, CA ESU		FT
Pogonichthys macrolepidotus	Sacramento splittail	CSC	FT
Spirinichus thaleichthys	Longfin smelt	CSC	FSC

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
FEDERAL: FE=endangered; FT=threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

a. Upper Sacramento River Basin. Before July 1991, 26 of the 40 miles of the Sacramento River below Box Canyon Dam was planted with catchable trout, and the lower 14 miles was managed as a wild trout stream. Rainbow trout was the dominant salmonid in the river, with some brown trout. Other species included hardhead, Sacramento squawfish, California roach, speckled dace, Sacramento sucker, and riffle sculpin. Smallmouth bass, Alabama spotted bass, and channel catfish live in the lower reaches. In July 1991, a train derailed while crossing the Sacramento River just north of Dunsmuir at the Cantarra Loop, spilling the chemical metam sodium from a ruptured tanker into the river and destroying downstream aquatic life. Fish and other aquatic life are gradually reappearing from upstream and tributary sources, as well as from Shasta Lake. The Department of Fish and Game has begun planting catchable trout in a 6-mile stretch near Dunsmuir; the lower 22 miles is a catch-and-release fishery.

Except in the South Fork Pit River above Likely, streams of the system above Fall River generally do not support significant fish populations because of the high mineral levels and intermittent flows. Principal sport fishing streams are Fall River, Hat Creek, Pit River below Fall River, and headwater streams of the South Fork.

The McCloud River supports an excellent sport fishery; rainbow trout is the dominant species. Access is limited and difficult along much of the lower portion of the river.

Shasta Lake supports a wide variety of coldwater and warmwater fish. Resident species include rainbow and brown trout, kokanee and landlocked chinook salmon, largemouth bass, smallmouth bass, spotted bass, black crappie, green sunfish, bluegill, brown bullhead, channel and white catfish, threadfin shad, Sacramento sucker, squawfish, and carp.

Warm water temperatures in the Sacramento River downstream from Shasta Dam have affected upstream salmon migration and caused egg mortality. The problem is most severe in early fall during dry years, when low flows of relatively warm water are further influenced by high air temperatures. Although high river temperatures are natural, operation of Shasta Dam has aggravated the problem. Temperatures are controlled somewhat by modifying operations and importing colder water from Trinity Lake, a part of the Trinity River facilities. Operation modifications include releasing colder water through lower dam outlets, which results in loss of power generation through hydroelectric facilities at the dam.

b. Lower Sacramento River Basin. The Sacramento River and tributaries between Keswick Dam and the Delta provide important habitat for a diverse assemblage of fish species, both anadromous and resident. Anadromous fish include chinook salmon (four races), steelhead trout, striped bass, American shad, green and white sturgeon, and Pacific lamprey. Approximately two-thirds of the striped bass population in the Delta spawn in the Sacramento River system, while the remainder spawn in the lower San Joaquin River. Resident fish can be separated into warmwater game fish (such as largemouth bass, white crappie, black crappie, channel catfish, white catfish, brown bullhead, yellow bullhead, bluegill, and green sunfish); coldwater game fish (such as rainbow and brown trout); and nongame fish (such as Sacramento squawfish, Sacramento splittail, delta smelt, Sacramento sucker, and golden shiner). Native nongame fish such as Sacramento perch (California's only native sunfish) are thought to be extirpated from the Delta and exist only in ponds and reservoirs. The native tule perch persists in the Sacramento River.

Keswick Reservoir supports both rainbow and brown trout, as well as some warmwater fish from Shasta Lake, including large and smallmouth bass. Keswick Dam forms a barrier to upstream migration of fish, primarily chinook salmon and steelhead. Fish trapping facilities at the dam are operated in conjunction with Coleman National Fish Hatchery on Battle Creek, 25 miles downstream.

Catfish, bluegill, sunfish, and bass are fished extensively in drains, channels, and ponds throughout the Colusa Basin. Most of the Yolo Bypass is dry and cultivated during much of the year, but irrigation and drainage canals and borrow ditches support warmwater fish. Resident species of the Sacramento River, Cache Creek, Willow Slough, Willow Slough Bypass, and South Fork Putah Creek may occupy the bypass during flooding. Game fish commonly caught include largemouth bass, black and white crappie, bluegill, redear and green sunfish, white and channel catfish, splittail, and black bullhead. Several nongame fish are also found, such as carp, goldfish, inland silverside, mosquitofish, bigscale logperch, and minnows. Sacramento sucker and Sacramento squawfish may also be found in the bypass. Anadromous fish such as striped bass, steelhead trout, American shad, Pacific lamprey and the four races of chinook salmon may be found in the Yolo Bypass when it is flooded. Anadromous fish runs in the lower Sacramento River and its tributaries have faced many problems including unscreened diversions, passage problems at some diversion structures, low stream flows, periodic high water temperatures and high sediment loads. There are a number of fishery restoration actions or projects taking place in the Sacramento Valley to correct these problems.

The State Water Resources Control Board has established a temperature objective of 56°F to be attained to the extent controllable throughout the Sacramento River spawning area between Keswick Dam and Red Bluff Diversion Dam. The operation of a temperature control device at Shasta Dam is expected to meet the objective most of the time. Temperatures below the upper lethal temperature of 62°F are maintained between Keswick Dam and Red Bluff except occasionally during August, September, and October. In September, temperatures remain below 62°F at Red Bluff in 75 percent of all years. Effects of Shasta Dam releases on water temperatures decrease with downstream distance. River temperatures are greatly affected by ambient air temperatures between the point of release and the Red Bluff Diversion Dam, particularly during summer. Ambient air temperature and tributary accretions combine to produce high summer river temperatures detrimental to some fish between Keswick Dam and Red Bluff Diversion Dam. Effects of high summer water temperatures are compounded in dry years.

In 1995, state legislation gave Mill and Deer creeks protection from future water development (similar to protection provided by the California Wild and Scenic Rivers Act), by restricting construction of new dams, reservoirs, diversions or other water impoundments. These two streams are among the last remaining vestiges of quality spring-run habitat in the Sacramento System. The

Mill and Deer Creek Watershed Conservancies were also formed in 1995 and have initiated a watershed planning and management process.

Butte Creek supports an anadromous fishery that includes a large spring-run and small fall-run population of chinook salmon as well as steelhead trout. Butte Creek has been the focus of several ambitious anadromous fish habitat recovery efforts. In 1995, M&T Chico Ranch and DFG agreed to install a new fish ladder at the Parrott Phelen Dam and new-screened diversions. M&T Ranch also dedicated 40 cfs of instream flow for fishery needs on Butte Creek. Western Canal Water District and private landowners agreed to remove the Point Four Diversion Dam near Nelson. During 1997, WCWD constructed a large inverted siphon at its former Butte Creek crossing and removed the Western Canal Dam. The siphon will separate the canal system from Butte Creek and eliminate fish losses caused by the diversion. Other dams on Butte Creek are scheduled to be removed or upgraded with fish ladders and diversion screens. An inventory and assessment of other potential fish passage improvements on lower Butte Creek and in the Butte Slough and Sutter Bypass areas is currently underway.

Big Chico Creek supports a remnant population of spring-run salmon, as well as some fall-run salmon. In 1996, M&T Ranch and Llano Seco Ranch pumps were relocated from the creek to the Sacramento River to eliminate a fish hazard at the mouth of the creek. The pumps created a substantial streamflow reversal which had impeded the passage of young out-migrating fish.

A number of Sacramento River water users have initiated fish screening projects for their diversions. The Pelger Mutual Water Company and Maxwell Irrigation District completed screens in 1995. Princeton-Codora-Glenn Irrigation District and Provident Irrigation District started construction on a new-screened pumping plant. Reclamation District 108 started building its new fish screen at its Wilkins Slough Diversion. Other fish screening facilities on the Sacramento River are being planned by Reclamation District 1008, Natomas Central Mutual Water Company, and Glenn-Colusa Irrigation District, and Browns Valley Irrigation District plans to install a fish screen on its diversion from the Yuba River.

c. Feather River. Construction of Oroville Dam on the Feather River eliminated spawning areas for salmon and steelhead upstream of the dam. To compensate for this loss, the DWR built the Feather River Fish Hatchery. About 23 miles of the Feather River below the Fish Barrier Dam is used for natural spawning. Juvenile salmon rear between the Fish Barrier Dam and the confluence with the Sacramento River. There appears to be limited natural steelhead spawning in the Feather River. Other species in the Feather River include American shad, striped bass, steelhead trout, and many resident warmwater and coldwater species.

d. Yuba River. Yuba River instream flows are governed by a 1965 agreement between YCWA and the DFG. Provisions include minimum flows for fish maintenance and controls to minimize streamflow fluctuations. The DFG has developed the Lower Yuba River Fisheries Management Plan which includes recommendations on instream flow, water temperature, and flow fluctuations. In 1993, flow requirements were modified in the system as part of the Federal Energy

Regulatory Commission (FERC) requirements for the relicensing of the Pacific Gas and Electric Company (PG&E) Narrows Project. The SWRCB held hearings to address flow and fishery needs of the Yuba River. A draft decision was issued by the SWRCB in 1999. However, no decision has been made to date.

Surveys in 1976 identified 28 species of resident and anadromous fish in the Yuba River system. Anadromous fish of special concern include chinook salmon, steelhead trout, and American shad. New Bullards Bar Reservoir supports both warmwater and coldwater fisheries. Common and abundant coldwater species include rainbow and brown trout; warmwater species include smallmouth and largemouth bass, crappie, bluegill, catfish, carp, Sacramento squawfish, Sacramento sucker, and threadfin shad. No rare or endangered species are known to inhabit the reservoir.

The fall-run chinook salmon is the most abundant anadromous fish in the lower Yuba River system. Historically, the Yuba River supported up to 15 percent of the Sacramento River fall run. In surveys from 1953 to 1989, the total number of adult fish ranged from 1,000 in 1957 to 39,000 in 1982. Fall-run chinook salmon typically begin migration into the Yuba

River in late September. Low flows and high temperatures may delay migration and spawning. Peak spawning occurs in October and November but has been known to continue into January. Fry emerge from the gravel between December and March. Some emigrate within a few weeks of emergence, while others rear in the river until June.

The original spring-run population had virtually disappeared from the Yuba River by 1959. Today's remnant spring run is probably the result of strays from the Feather River or the infrequent stocking of hatchery-reared fish by the DFG. Spring-run chinook salmon migrate into the Yuba River as early as March and as late as August. Generally, most of the run migrates in May and June. The adults spend the summer in deep pools in the Narrows reach of river, where water temperature seldom exceeds 60°F. Spawning can begin in August, but the peak is between September and October. Fry emergence begins in November and extends through January. Emigration can occur within a few weeks of emergence, or the juveniles can rear in the area until June.

The Yuba River supports one of the only self-sustaining populations of steelhead in the Central Valley. Up to 200,000 yearling steelhead were stocked annually from Coleman National Fish Hatchery from 1970 to 1979. It is unknown whether the present stock is of native origin or derived from Coleman NFH. It is currently managed as a self-sustaining population.

e. American River. Largemouth and smallmouth bass, white catfish, brown bullhead, channel catfish, and several sunfishes are among species found in Folsom Lake. During normal water years, the DFG plants hatchery-spawned rainbow trout and manages the reservoir to maintain kokanee salmon planted previously. At the Lake Natoma-Nimbus Dam afterbay complex, daily 4 to 7 foot water level fluctuations, cold water temperatures, and limited food production support few fish. Anadromous fish cannot pass Nimbus Dam. However, the DFG operates the Nimbus Salmon and Steelhead Hatchery just downstream of the dam to compensate for the loss of fish passage.

The lower American River flows within a restricted channel isolated from surrounding urban areas by 30-foot levees. Native riparian vegetation, backwater, dredge ponds, and urban recreational areas such as parks and golf courses border the waters' edge. The river and backwater areas support at least 40 species of fish, including chinook salmon, steelhead trout, striped bass, splittail, and American shad. Common resident fish include Sacramento sucker, black bass, carp, squawfish, and hardhead.

From 1969 to 1981, salmon spawning escapement to the American River and Nimbus Hatchery averaged 47,500. The proportion of hatchery vs. naturally produced fish in the annual escapement has not been estimated with any accuracy, due to insufficient data. During prolonged drought, low water levels at Folsom Dam have resulted in releases of warmer water, which ranges from marginal to lethal thresholds for salmon eggs spawned in the river and the hatchery.

8. Wildlife

A wide variety of wildlife species are found in the Sacramento River Basin. DFG's Wildlife Habitat Relationship Program identifies a total of 249 species of wildlife using the valley and foothill habitat of the Sacramento Valley. Included in this total are 151 species of birds, 65 species of mammals, and 33 reptile and amphibian species. Riparian zones also provide food and cover to other wildlife species more typical of adjacent upland areas and provide migratory corridors for many others. Riparian areas are also valuable habitats for numerous species of mammals, including furbearers. Between Red Bluff and the Delta, populations of most species that are dependent on riparian, oak woodland, marsh and grassland habitats have declined with the conversion of these habitats to agriculture and urban areas.

Many birds are common year-round or are seasonal residents of the Sacramento Valley; others are migrants or occasional visitors. Since the Sacramento Valley lies on the Pacific Flyway, its wetlands provide prime waterfowl habitat; the wintering population often exceeds 3 million. The Rice Straw Burning Reduction Act of 1991, which resulted in additional ricefield flooding, has helped create new winter habitat for migratory waterfowl. Waterfowl in the valley include mallards, northern pintails, widgeons, tundra swans, Canada geese, snow geese, and 20 other species. Shorebirds such as great blue herons, great egrets, and spotted sandpipers use riverbanks, sandbars, riparian vegetation, and emergent or submerged aquatic vegetation and forage on small mollusks, fish, and crustaceans.

Songbirds are found in large numbers in the riparian vegetative cover along the Sacramento River and its tributaries. Goldfinches, song sparrows, rufous-sided towhees, and American robins are some of the passerine species that use the trees, shrubs, and herbaceous plant species of the riparian habitat. Western meadowlarks, loggerhead shrikes, and American crows are found in the grassland and agricultural areas. Raptors such as Swainson’s or red-tailed hawks and great-horned owls nest in the larger trees of the riparian and grassland habitat and feed on voles, gophers, and other prey. Commonly observed birds of prey include red-tailed hawks, northern harriers, American kestrels, and burrowing owls. Game birds include ring-necked pheasants, mourning doves, California quail, and wild turkeys.

Mammals typical of the Sacramento River Basin include mule deer, mountain lions, bobcats, cottontail rabbits, and deer mice in the foothill habitats. Opossums, American badgers, raccoons, red foxes, gray foxes, river otters, beavers, muskrats, black-tailed hares, and small rodents are found throughout the grassland/riparian/wetland habitats. A DFG field study concluded that much of the Sacramento River riparian vegetation provides high quality habitat for furbearers; 14 species were recorded. Other species such as coyotes, California ground squirrels, and striped skunks occur throughout the basin.

Reptile and amphibian species are associated with upland, grassland, and riparian vegetation. The western fence lizard, northern Pacific rattlesnake, common king snake, and gopher snake are common reptiles in the Sacramento Valley. Amphibians such as bullfrogs, Pacific treefrogs, and western toads are usually restricted to riparian or lacustrine habitat, but some, such as California tiger salamanders, use the temporary wetlands habitat of vernal pools.

With conversion of riparian, oak woodland, wetland, and grassland habitats to agriculture and urban uses, populations of most species dependent on these habitats have declined. Populations of some Sacramento Valley species have declined so greatly that they have been listed as threatened or endangered or are under study for future listing. Table III-12 lists sensitive wildlife species in the Sacramento River Basin.

There are 188 designated Significant Natural Areas (SNAs), as defined by the DFG, in the Sacramento River Basin. These areas contain important habitats that support special-status wildlife species. Many of these habitats occur in riparian areas along the Sacramento River. Other areas include vernal pool and grassland habitats found throughout the region and marsh habitats in the southern portion of the region. Wetland areas of the basin are important as prime waterfowl wintering areas in the Pacific Flyway.

9. Recreation

Major recreation sites in the Sacramento River Basin include the key lakes and reservoirs (Shasta Lake, Whiskeytown Lake, Lake Oroville Complex, Folsom Lake, New Bullards Reservoir Bar, and Englebright Lake), key rivers and streams (the Sacramento, Feather, American, and Yuba Rivers and Clear Creek), and key federal wildlife refuges and state wildlife management areas (the Sacramento National Wildlife Refuge (NWR) Complex and Gray Lodge Wildlife Management Area (WMA)). Waterfowl and upland game hunting on private lands is also a leading form of recreation in the region. Other areas potentially affected by the water rights decision are Keswick Reservoir, Lake Red Bluff, Camp Far West Reservoir, and the Bear River below Camp Far West Reservoir.

Table III-12
Sensitive Wildlife Species in the Sacramento River Basin

Scientific Name	Common Name	Status State	Status Federal
Agelaius tricolor	Tricolored blackbird	CSC	FSC
Branta canadensis leucopareia	Aleutian Canada goose		FT
Buteo swainsonialassina	Swainson' hawk	ST	
Coccyzus americanus occidentallis	Western yellow-billed cuckoo	SE	
Empidonax traillii	Willow flycatcher	SE	
Grus canadensis tabida	Greater sandhill crane	ST	
Haliaeetus leucocepohalus	Bald eagle	SE	FT
Plegadis chihi	White-faced ibis	CSC	FSC
Riparia riparia	Bank swallow	ST	
Vireo bellii pusillus	Least Bell's vireo	SE	FE
Antrozous pallidus	Pallid bat	CSC	
Plecotus townsendii townsendii	Townsend's western big-eared bat	CSC	FSC
Ambystoma californiense	California tiger salamander	CSC	C
Hydromantes shastae	Shasta salamander	ST	FSC
Rana aurora draytonii	California red-legged frog	CSC	FT
Clemmys marmorata	Western pond turtle	CSC	
Thamnophis gigas	Giant garter snake	ST	FT
Branchinecta conservatio	Conservancy fairy shrimp		FE
Branchinecta lynchi	Vernal pool fairy shrimp		FT
Desmocerus californicus dimorphu	Valley elderberry longhorned beetle		FT
Lepidurus packardi	Vernal pool tadpole shrimp		FE
Pacifastacus fortis	Shasta crayfish	SE	FE

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

a. Reservoirs. Between 1945 and 1970, flatwater recreation opportunities became more extensive in the Sacramento River Basin as lakes, reservoirs, and recreation facilities were constructed. During that period, Shasta and Folsom lakes provided most of the flatwater recreation opportunities in the region. In 1970, the combined annual recreation use at Shasta Lake, Folsom Lake, Whiskeytown Lake, and Lake Oroville totaled approximately 5.6 million visitor days. By 1990, this combined total had risen to approximately 6.4 million visitor days.

Shasta Lake. Shasta Lake, approximately 10 miles north of Redding, is a unit of the Whiskeytown-Shasta-Trinity NRA. Recreation facilities and activities are administered by USFS. When full, the lake has a surface area of approximately 30,000 acres, 370 miles of shoreline, and a surface elevation of 1,067 feet above mean sea level (msl). The lake has four main arms: Sacramento River, McCloud River, Pit River, and Squaw Creek.

Shasta Lake accommodates a wide variety of water-dependent and water-enhanced recreation activities. Water-dependent activities are power boating, house boating, water-skiing, and fishing. Water-enhanced activities include camping and sightseeing.

Six public boat ramps and 13 private marinas support boating activities at the lake. Some private marinas also provide boat launch facilities. The main body of the lake and all the major arms except Squaw Creek arm have at least one boat ramp. The marinas are clustered at the northern end of the Sacramento River arm, along the western shore of the McCloud River arm and at the Jones Valley area on the Pit River arm. In 1991, these marinas provided an estimated 2,890 mooring spaces. Most marinas provide boat storage, houseboat rental, boat repair, and boating and camping supply sales.

The lake has no designated swimming areas. Because of limited shore access and steep slopes, most of the swimming activity occurs from boats or near campgrounds. The lake's one designated fishing area/picnic area is adjacent to Shasta Dam, and two picnic areas are located on the McCloud River arm.

Camping facilities are provided at 22 public campgrounds, most of which are located on the upper reaches of the Sacramento River arm, with the remaining campgrounds located near Jones Valley on the Pit River arm and along the western shore of the McCloud River arm. Four of the campgrounds are accessible by boat only.

Almost the entire surface area of the lake is accessible by boat. High-speed boating activities such as water-skiing and cruising are allowed on most of the lake except for the ends of the arms and some coves where speeds are restricted for safety reasons.

Fishing at Shasta Lake occurs from boats and along the lakeshore. The most frequently caught species are rainbow trout, smallmouth bass, and crappie. Although the entire lake offers fishing opportunities from boats, the most popular fishing area is near Jones Valley, which also provides easy access to the Pit River and Squaw Creek arms. Because much of the shoreline is accessible by boat only, fishing from shore is concentrated at access points near Shasta Dam and along the arms of the lake. Shore fishing access points are found along the northern end of the McCloud River arm, at Jones Valley on the Pit River arm, at the northern end of the Sacramento River arm, and adjacent to Shasta Lake. Because of the lack of cover, the best fishing sites for warm-water fish at the lake are under or near structures such as docks or bridges. Shore fishing is also popular at the ends of the major arms where rivers enter the lake.

During 1992, use at Shasta Lake totaled approximately 7.3 million visitor days. Of this total, approximately 4.1 million visitor days involved water-dependent activities.

Public boat ramps on the lake begin to cease operation as the lake level falls 75 feet from full to a surface elevation of 992 feet above msl. The last public boat ramp on the main area of the lake ceases operation when the lake level falls 223 feet to a surface elevation of 844 feet above msl; on the Sacramento River arm, when the lake falls 117 feet to a surface elevation of 950 feet above msl; on the Pit River arm, when the lake falls 125 feet to a surface elevation of 942 feet above msl; and on the McCloud River arm, when the lake falls 115 feet to a surface elevation of 952 feet above msl. When the last ramp ceases operation, launching boats from trailers becomes difficult because of steep slopes and muddy shore conditions.

Most marinas remain in operation as the lake level falls. Marinas on the main portion of the lake, the Pit River arm, McCloud River arm, and the lower portion of the Sacramento River arm move in response to lower lake levels. Marinas at the end of the Sacramento River arm are not as flexible as other marinas because of the long, narrow channel and relatively shallow water in this area. Most marinas are first forced to move when the lake recedes 80 feet to a surface elevation of 987 feet above msl. Marinas at the end of the Sacramento River arm are first forced to move as the lake drops 60 feet to a surface elevation of 1,007 above msl. These marinas are typically forced out of operation as the lake falls 130 feet to a surface elevation of 937 feet above msl.

Camping becomes less popular as the lake level drops because of the increased distance between the campgrounds and the lakeshore, which affects boaters attempting to reach the campground and campers attempting to reach the lake. As the lake level falls, campgrounds located along the relatively shallow upper reaches of the arms of the lake become less popular than those near deeper waters do.

Because Shasta Lake is so large, most water-dependent activities remain available as the lake level falls, as long as access is maintained. However, boating activities become more constrained as hazards such as submerged islands, rocks, and snags appear. Generally, these hazards appear within the shoreline zone as the lake level drops 240 feet to a surface elevation of 827 feet above msl.

Whiskeytown Lake. Whiskeytown Lake is approximately eight miles west of Redding on the eastern slope of the Coast Range. A unit of the Whiskeytown-Shasta-Trinity NRA, the lake is administered by the NPS. When full, the lake has a surface area of 3,250 acres, 36 miles of shoreline, and a surface elevation of 1,210 feet above msl.

Whiskeytown Lake accommodates a variety of recreation activities, such as boating, fishing, swimming and beach use, and camping. Power boating, water-skiing, and sailing are popular boating activities. Fishing occurs from boats and along the shoreline. Swimming and beach use occur at designated areas and in dispersed areas along the lakeshore.

One marina and three boat ramps support boating activities at Whiskeytown Lake. The marina is along the northwestern shore of the lake and is easily accessible from State Route (SR) 299. Two of the boat ramps are on the northwestern side of the lake at Oak Bottom and on the Whiskey Creek arm; the third is at Brandy Creek on the south shore of the lake. The boat ramps at Oak Bottom and Whiskey Creek are easily accessible from SR 299. High speed boating activities are allowed on most of the lake except for the Clear Creek arm between the Judge Francis Carr Powerhouse and Oak Bottom.

Fishing occurs both from boats and along the lakeshore. The most frequently caught species are rainbow trout and kokanee salmon. The most popular shore fishing area is near the Judge Francis Carr Powerhouse because the water released from the powerhouse attracts planted fish.

Swimming and beach use are concentrated at the designated areas at the mouth of Brandy Creek on the south side of the lake and at Oak Bottom on the northwestern shore. Most of the lakeshore is open to the public, with the most popular informal swimming and beach areas along the eastern shore of the lake near the park headquarters and along SR 299. Swimming and beach use at informal sites along the lakeshore are constrained when the lake is full because of limited access.

Camping areas located at Brandy Creek, Oak Bottom, and Dry Creek provide a total of 187 camping spaces. Brandy Creek is a dispersed camping area, Oak Bottom provides tent and recreation vehicle (RV) spaces, and Dry Creek is a group camping area.

In 1992, recreational use at Whiskeytown Lake totaled approximately 833,000 visitor days. The most popular water-dependent activities at the lake are swimming and beach use, boating, and fishing.

Whiskeytown Lake is normally maintained at a relatively stable water level by the USBR. Historically, the lake is kept full during spring and summer when visitation is highest. The lake typically has an off-season drawdown of approximately 11 feet because water is not diverted into Whiskeytown Lake from Lewiston Lake. Recreation activities can become constrained as the lake level declines because facilities have been designed for use at higher levels. Lake levels of 1,209 feet above msl during summer and 1,198 feet above msl during winter are ideal for typical recreation activities during these seasons.

Boat access becomes constrained at Whiskey Creek and Oak Bottom ramps when the lake level drops 13 feet from full to a surface elevation of 1,197 feet above msl. Both ramps cease operation when the lake drops 15 feet to a surface elevation of 1,195 feet above msl. The Brandy Creek ramp ceases operation at a surface elevation of 1,190 feet above msl, or 20 feet below full. Boats with fixed keels, such as sailboats, cannot be launched when the lake level drops below 1,190 feet above msl.

Operation of the marina at Oak Bottom becomes constrained as the lake level drops to 1,204 feet above msl, or 6 feet from full. At this lake elevation, the marina operator must begin to reposition slips. At a lake level of 1,198 feet above msl, or 12 feet from full, the marina cannot be used.

Shoreline activities outside the designated swimming areas are enhanced as the lake level falls to an elevation of approximately 1,206 feet above msl, or 6 feet from full. Because of steep slopes and dense vegetation, exposing shoreline around the lake enhances access. Below 1,206 feet above msl, a wide band of shoreline devoid of vegetation affects the visual character of the lake.

Swimming and beach use at the Brandy Creek and Oak Bottom swimming areas become constrained as the lake level falls to approximately 1,206 feet above msl, or 4 feet from full, because the lake level drops below the sandy beach area.

Because the lake has historically been full during peak visitation periods, it is not clear how water-dependent activities are affected by lowered lake levels. Shore fishing can be enhanced by improved shore access as the lake level falls. The most popular fishing area on the lake, immediately below the Judge Francis Carr Powerhouse, is not affected by lowered lake levels because it depends more on flows from the powerhouse. Fishing at this site becomes less popular during winter because water is not diverted from Lewiston Lake.

Lake Oroville Complex. The Lake Oroville Complex, managed by the California Department of Parks and Recreation (DPR) as part of the Lake Oroville State Recreation Area (SRA), is on the Feather River in Butte County. The complex includes Lake Oroville and Thermalito Forebay and Afterbay. When full, Lake Oroville has a surface area of 15,800 acres, 167 miles of shoreline, and a surface elevation of 900 feet above msl.

Most of Lake Oroville SRA's formal recreation facilities are at the lake. The facilities accommodate boating, water-skiing, sailing, fishing, swimming, boat-in camping, and overnight camping. Unrestricted boat access to the shoreline is allowed for camping uses. Boating access is provided at three paved ramps in the southern reservoir area near Lake Oroville and on the West Fork Feather River. Car-top boat launching is allowed on all but the Middle Fork Feather River.

Day and overnight use areas at Lake Oroville are located along the main reservoir and tributary shorelines. Bidwell Canyon and Loafer Creek on the southern shoreline and Lime Saddle on the West Fork Feather River are the major use areas. A visitor center on Kelly Ridge overlooks the dam and lake. Camping is allowed along the shoreline and at boat-in camping areas at Craig Saddle, Foreman Creek, Bloomer Primitive Camp, and Potter Ravine. The Bidwell Canyon marina provides covered berthing slips, a store and snack bar, fuel dock, boat rental, and open mooring. Swimming is allowed along the shoreline. Designated swimming facilities are provided at the Loafer Creek unit only, at the southern end of the lake.

Fishing occurs throughout the lake from boats and the shoreline. Game fish are planted in the lake annually; rainbow trout and largemouth and smallmouth bass are the most frequently caught species.

Recreation activities in the 600-acre Thermalito Forebay are accommodated by day-use facilities that feature a turf picnic area, 200-yard-long swimming beach, and two-lane boat ramp. The forebay is reserved for sailboats, canoes, and other non-motorized boating. Facilities at Thermalito Afterbay consist of a parking lot, four-lane boat ramp, and chemical toilets. Fishing and motorized boating are the main recreation activities at the afterbay. Shore and boat fishing at the forebay and afterbay are primarily for rainbow trout, catfish, and largemouth and smallmouth bass.

Visitation at the Lake Oroville Complex totaled approximately 600,000 visitor days in 1992. Day use and overnight camping account for most of the recreation use. When the lake is full, recreation facilities are available and boating and water sports are optimized. In general, most water-oriented use is substantially reduced at or below an elevation of 750 feet above msl (150 feet below full), and obstacles are buoyed for safety reasons.

When the lake level falls to an elevation of 775 feet above msl, boat ramps at Loafer Creek cease operation, followed by Lime Saddle at 750 feet above msl, Spillway at 730 feet above msl, and Bidwell Canyon at 710 feet above msl. Car-top boat launching areas at the Enterprise and Stringtown access points cannot be used below lake elevations of 835 feet and 866 feet above msl, respectively. The designated swimming beach at Loafer Creek begins to be affected at a surface elevation of 860 feet above msl because the lake level falls below the designated beach areas. Recreation activities at the Thermalito Forebay and Afterbay are not directly affected by water level fluctuations because surface water elevations at these control reservoirs are generally maintained at constant levels.

Folsom Lake. Folsom Lake SRA, managed by DPR, is located on the American River east of Sacramento. The SRA includes both Folsom Lake and Lake Natoma. When full, Folsom Lake has a surface area of 11,450 acres, 75 miles of shoreline, and a surface elevation of 466 feet above msl. Lake Natoma, a potentially affected recreation area, is included in this description because DPR does not report use of the two lakes separately.

Folsom Lake SRA facilities accommodate a variety of water-oriented recreational activities including boating, fishing, swimming, jet skiing, windsurfing, and sailing. Camping, picnicking, and trail facilities are also provided in the lake watershed. Boat launches along the 75-mile shoreline provide boat access. Major use areas are Beals Point, Granite Bay, and Rattlesnake Bar on the western shoreline; Dike 8, Mormon Island, and Brown's Ravine Marina on the southern and eastern shorelines; and the Peninsula Campground between the north and south forks of the American River. Brown's Ravine Marina provides 670 berthing slips for year-round mooring and small craft rentals.

Fishing occurs from boats throughout the lake and especially in the upper arms that are designated as slow-boating zones. Fishing is mainly for rainbow trout and warm-water species. Swimming and sunbathing areas are provided at the designated Beals Point and Granite Bay beaches and at numerous non-designated areas along the reservoir shoreline. Boating, sailing, water-skiing, and other watercraft uses are popular activities throughout the main reservoir area.

Lake Natoma covers 500 acres, approximately 6 miles downstream of Folsom Lake. Lake Natoma has approximately 10 miles of shoreline, a maximum pool of 126 feet, and a maximum daily drawdown of approximately 7 feet. Picnic and camping areas and a boat ramp are located at

Negro Bar, environmental camping at Mississippi Bar, and boat launch facilities near Nimbus Dam and Willow Creek. The western shoreline also features an 8.4-mile portion of the popular American River bicycle trail. Recreation activities include fishing, non-motorized boating, and windsurfing. Lake Natoma is less heavily used for swimming and wading than Folsom Lake because of its cooler water temperature.

In 1992, visitation to the entire Folsom Lake SRA was estimated at 2.1 million visitor days. The SRA is one of the most heavily used units in the California state park system, primarily because of its proximity to the Sacramento metropolitan area, the arid summer climate, and high regional interest in recreation.

Water-dependent activities dominate Folsom Lake recreation use, accounting for more than 80 percent of the annual recreation use. Boating, the most popular activity at the lake includes launch and non-launch boating, windsurfing, and jet skiing.

The optimal lake elevation for recreation use is 436 feet above msl, or a surface area of 9,600 acres, because all facilities can be used at this elevation. Beaches can accommodate high use at this level, and boat ramp and parking facility use is maximized. Lake elevations higher than 436 feet above msl reduce the capacity of the lake because some boat ramps and parking spaces are inundated. When the lake level falls to an elevation of 426 feet above msl, Brown's Ravine Marina ceases operation. At elevation 420 feet above msl (8,500 surface acres), most of the boat ramps cannot be used and at elevation 405 feet above msl (7,300 surface acres), only one boat ramp can be used. At 401 feet above msl, all boat ramps are out of service.

Lake surface elevations have the greatest effect on recreation between April and August because visitation is greatest during these months. Although fluctuating elevations in winter can substantially affect recreation activities, only small proportions of the total annual users are affected. Boat ramps and recreation use areas at Lake Natoma are not substantially affected by lake drawdown because water levels are kept stable during the primary recreation season.

New Bullards Bar Reservoir. New Bullards Bar Reservoir is located on the Yuba River in Yuba County. The YCWA owns the lake, and the USFS provides recreation facilities and management. The lake has a surface area of approximately 4,800 acres.

The reservoir accommodates water-oriented recreation uses, including boating, water-skiing, fishing, and swimming. Picnicking, camping, and trail uses are also accommodated. Boat access is provided at the Cottage Creek boat ramp on the southwestern shore of the reservoir and at the Dark Day boat ramp 4 miles north of the dam on the eastern shoreline. The Emerald Cove Marina located at the Cottage Creek boat ramp provides a store, snack bar, 31 berthing slips for small crafts, mooring areas, and houseboat and fishing boat rentals. Currently, 42 houseboats are moored year-round at the reservoir.

The major use areas near the reservoir are the Burnt Bridge Campground and the Dark Day Campground and picnic area, both on the west side of the lake. Boat access camping is provided at the Garden Point, Frenchy Point, and Madrone Cove campgrounds.

Water-skiing is allowed throughout the reservoir at 200 feet from the shoreline. Boat and shore fishing opportunities are available for cold- and warm-water species. DFG manages the reservoir primarily for kokanee salmon and releases 220,000 to 250,000 fingerlings annually. The reservoir shoreline has no designated swimming areas.

Visitation to New Bullards Bar Reservoir was estimated at approximately 222,000 visitor days in 1992. Water-oriented activities dominate annual recreation use at the reservoir. Reservoir use patterns indicate high use of overnight camping and boat ramp facilities and low use of picnic areas. Occupancy rates at the two boat ramps are consistently more than 100 percent on weekends, with the heaviest use recorded at the Cottage Creek boat ramp. The reservoir shoreline areas most heavily used for day and overnight uses are the Little Oregon Creek area, the Garden Valley Road area, and the Bridger Creek and Brandy Creek shoreline areas in the extreme northeastern reservoir arm.

The maximum water surface elevation is 1,956 feet above msl. The Cottage Creek boat ramp ceases operation at 1,832 feet above msl, and the Dark Day boat ramp cannot be used at 1,798 feet above msl. The Emerald Cove Marina is operational at all lake levels.

Englebright Lake. Englebright Lake, owned and operated by the USCOE, is on the Yuba River downstream of New Bullards Bar Reservoir. The USCOE also provides recreation facilities and management. When full, the lake has a surface area of approximately 760 acres and an elevation of 534 feet above msl.

Englebright Lake facilities accommodate water-dependent recreation activities, such as boating, water-skiing, fishing, and boat-in camping. Boat access is available at the Narrows and Joe Miller Ravine boat ramps (four lanes total). The Narrows and Joe Miller Ravine recreation areas provide nearly all the day-use facilities; overnight camping and houseboat mooring areas spread out over approximately 9 miles of the lake. Skippers Cove Marina at the Joe Miller Ravine recreation area provides 223 berthing slips and mooring areas.

Water-skiing is allowed on approximately half the lake, with a no-ski zone enforced on the upper reach. Fishing occurs primarily in the northern half of the lake during the summer recreation season. Englebright Lake fisheries consist primarily of planted rainbow trout, kokanee salmon, and warm-water species. DFG stocks the lake with approximately 22,000 catchable-sized trout per year.

Visitation to Englebright Lake was estimated to total 137,000 visitor days in 1992. Visitation has increased substantially in recent drought years because of the relatively stable and full water levels. Boating, water-skiing, fishing, and swimming are popular activities. More than 80 percent of the lake's visitation is day use.

Surface water levels at Englebright Lake are stable as a result of operations of New Bullards Bar Reservoir upstream. When levels fall below 500 feet above msl (25 feet below full), the Narrows recreation area boat ramp cannot be used. At elevation 510 feet above msl (15 feet below full), the Joe Miller Ravine boat ramp cannot be used. During recent drought years, Englebright Lake was at full pool through the peak summer months. Fall drawdown is approximately 15 feet to provide flood storage.

b. Rivers. Construction and operation of the lakes and reservoirs that provide flatwater recreation opportunities have substantially affected instream uses below them. A sport fishery boom occurred in the Sacramento River in the years following construction of Shasta Lake as changes in water temperature and flow regimes benefited anadromous fish and adversely affected warm-water species. By the 1980s, the salmon and steelhead sport fishery had declined as diversions increased and instream flows decreased.

The Sacramento River environment provides the most important recreational resource for local residents. Over 2 million visitors participate in recreational activities along the Sacramento River annually. Fishing and relaxation are the most popular recreational activities. Other types of recreation include boating, water-skiing, swimming, camping, picnicking, hiking, sightseeing, bird watching and outdoor sports. Winter-run chinook salmon fishing was very popular prior to the severe decline in the population and current harvest restrictions. Striped bass, American shad, steelhead trout and spring, fall, and late-fall salmon runs remain popular among recreational anglers along the river.

Numerous public and private facilities provide recreational access along the Sacramento River between Keswick Dam and Red Bluff. Fishing is excellent along this stretch of the river. Rafting, kayaking, and canoeing are also popular because the river is fast flowing and there are a number of riffle areas. Fishing and hiking occur throughout the year, while picnicking and camping are limited to the spring through fall months. Water contact sports, such as swimming, kayaking, and canoeing, are generally restricted to the summer months where the daytime temperatures are often over 100EF.

Between Red Bluff and the Delta, little recreation land is available in the Sacramento Valley outside of riparian corridors. Public access to the river for recreational use is limited by the amount of public lands along the river. About 65 percent of the total recreational use on the river at and above Sacramento is by people living in counties adjacent to the river. Ninety percent of the summer day use activity is by local residents.

Sacramento River - Upper Reach - Shasta to Bend Bridge. The upper reach of the Sacramento River is approximately 60 miles long and flows through the foothill area of the northern Sacramento Valley. Relatively rapid flows and scenic views characterize this reach. The river flows through developed areas in Redding and Anderson and then passes through unpopulated foothills before reaching Red Bluff.

Although most of the upper reach flows through private lands, public access is more readily available than along the middle and lower reaches. Public access points are provided by the cities of Redding and Anderson, Tehama County, the State of California, and the BLM. Access points along this reach of the river include a 1-mile segment between Keswick Reservoir and Lake Redding (owned by the BLM and managed by the City of Redding) and Lake Redding Park and Turtle Bay Recreation Area (also managed by the City of Redding). Other popular access areas are Anderson River Park, managed by the City of Anderson, and a 7-mile segment below Jelly's Ferry, managed by the BLM.

Fishing is the most popular water-dependent activity on this reach. Water-contact activities, such as swimming and tubing, are not popular because the water is cold and flows swiftly. Popular water-enhanced activities include picnicking and sightseeing.

Sacramento River - Middle Reach - Bend Bridge to Knights Landing. This reach of the river is approximately 160 miles in length and is characterized by slower moving water and a meandering river channel lined with riparian thickets and orchards. Although most land along this reach is privately owned, some public access is provided by counties through which the river passes and by the DPR.

The DPR and Tehama, Glenn, Colusa, and Sutter counties provide access points along the middle reach. Private facilities, primarily fishing access points, marinas, and resorts are located along the entire reach. This reach of the river also includes the Woodson Bridge SRA.

Water-dependent activities in this reach include boat and shore fishing and swimming and beach use. Water-contact activities, such as swimming and tubing, are popular in this reach because the water is relatively warm compared to that in the upper reach. Water-enhanced activities include camping and relaxing.

Sacramento River - Lower Reach - Knights Landing to Courtland. The lower reach, between its confluence with the Feather River and Courtland, is an 80-mile segment of the river. Slow-moving water and a meandering river channel characterize the upper 20 miles. Near Sacramento, the character of the river changes because of urban influences such as levees and commercial development along the river. Between Sacramento and Courtland, the river passes through agricultural areas.

The City and County of Sacramento and DPR provide public access points along the lower reach. Private facilities, primarily marinas, are located along the entire reach. This reach of the river also includes Discovery Park at the confluence with the American River.

Fishing and boating are popular water-dependent activities on this reach. Water-contact activities such as swimming and beach use, are also popular. Water-enhanced activities include picnicking and relaxing.

Feather River. The lower Feather river flows approximately 40 miles from Oroville Dam to its confluence with the Sacramento River, largely through private lands. Major recreation areas along the river are the Oroville Wildlife areas south of Lake Oroville, Riverfront Park in Marysville, and Lake of the Woods Wildlife Area near its confluence with the Bear River. Boat access between Oroville and Marysville is provided at Marysville Riverfront Park and near the communities of Live Oak, Gridley, and Biggs. Undeveloped access points downstream of Marysville are located along Garden Highway, which generally borders the river to Verona.

Water-dependent recreation on the river consists of boat and shore fishing, pleasure boating, and swimming. Water-enhanced recreation activities include sightseeing, picnicking, and camping.

American River. The American River Parkway, a 23-mile-long river corridor, crosses the Sacramento metropolitan area between Nimbus Dam and the confluence with the Sacramento River at Discovery Park. The parkway, managed by the Sacramento County Parks and Recreation Department, is recognized as one of the nation's premier urban parkways.

The river corridor, an approximately 6,000-acre open space area, consists of a broad river channel with dense riparian vegetation. It features 28 automobile access points and 68 access points for pedestrians, equestrians, and bicyclists. The Jedediah Smith National Recreation Trail provides bicycle, pedestrian, and equestrian trails from Discovery Park to the Folsom Lake SRA. The parkway includes a series of 14 parks distributed on publicly owned lands.

Water-dependent activities on the lower American River include rafting, boating, fishing, swimming, and wading. Water-enhanced activities include picnicking, hiking, bicycling, and equestrian recreation.

Yuba River. The lower Yuba River flows from Englebright Lake and meets the Feather River at Marysville, a distance of approximately 20 miles. Most of this section of the river flows through private lands, restricting public access. No public recreation facilities exist along the river. Limited public access is available at the SR 20 crossing 5 miles downstream from Englebright Lake, at the end of Hallwood Boulevard about 8 miles upstream of the confluence with the Feather River, and through Riverfront Park in Marysville. Powerboat access to the river is possible from launches on the Feather River near its confluence with the Yuba River. Boats traveling up the river are constrained by flows and cannot pass Daguerre Point Dam approximately 10 miles upstream from the confluence with the Feather River.

Fishing is the primary recreation activity on the river. Important game fish include chinook salmon, steelhead, and American shad. Striped bass are also caught, although incidentally compared to other fish. Fishing occurs from the shore at access points available to the public and on the river from boats that travel upstream from the Feather River and from drift boats launched near the SR 20 crossing.

Clear Creek. Clear Creek flows from Whiskeytown Lake and discharges to the Sacramento River just south of Redding. The upper four miles of the creek flow through the Whiskeytown Unit of the Whiskeytown-Shasta-Trinity NRA. Most of the remaining 13 miles flow through private land. The upper half of the creek passes through steep terrain with many falls and cascades, whereas the lower portion has a flatter gradient with few cascades or falls.

No formal recreation facilities are found along the creek. The National Environmental Education Camp, administered by the NPS, is approximately 1.5 miles below Whiskeytown Dam and is used primarily by surrounding school districts. Public access is allowed along the portion of the creek that flows through the Whiskeytown-Shasta-Trinity NRA and at the mouth of the creek over a City of Redding easement. However, access is difficult because of the steep terrain. Popular recreation sites include the Redding Bar and Saeltzer Dam areas; both located on private lands on the lower portion of the creek. Recreation activities along the creek include swimming, beach use, relaxing, fishing, camping, picnicking, hiking, and tubing.

Bear River. The Bear River below Camp Far West Reservoir is a 20-mile-long reach that crosses private agricultural land in Placer, Yuba, and Sutter counties on a westerly route to its confluence with the Feather River north of the town of Nicolaus.

No public recreation facilities or public access sites are provided along this portion of the river. Informal access is available at the Forty-Mile Road crossing and McCourtney Road crossing near Camp Far West Reservoir. Recreation activities include warm-water fishing, sightseeing, and informal picnicking during winter and spring. Fishing activity is mainly for bass, catfish, and other warm-water species that move upstream from the Feather River or escape from Camp Far West Reservoir when flows are released to the river.

c. Wildlife Refuges. Recreation activities at the federal wildlife refuges and State WMAs which receive surface water diversions could be affected by the proposed actions. The NWRs in the Sacramento River Basin include Sacramento, Delevan, Sutter, and Colusa refuges managed as the Sacramento NWR Complex. Gray Lodge WMA is a State owned facility managed by the DFG.

Most recreation activities on the refuges are associated with the presence of waterfowl and upland game birds. These activities include hunting, hiking, and wildlife observation. Hunting of ducks, geese, and pheasants is permitted between October and January on portions of each refuge. Fishing is permitted at Delevan NWR from February to October and at Gray Lodge WMA. Facilities include parking areas, blinds, a visitor center at the Sacramento NWR, interpretive trails, viewing platforms, and self-guided driving tours.

d. Private Hunting Clubs. There are over 500 private hunting clubs in the Sacramento River Basin encompassing approximately 227,000 acres. Approximately 123,000 acres are flooded annually and much of the water comes from surface water diversions. These private clubs provide opportunities for hunting ducks, geese, and pheasants, and are an important component of the economy.

The Butte Basin is one of the least developed floodplains in the Sacramento Valley and lies in the heart of the Pacific Flyway. Over 50 percent of the ducks and geese that overwinter in California use the basin. The lower portion of the basin, known as the Butte Sink, still has extensive marshland and riparian habitat. Much of the land in the basin is owned by private clubs and devoted to waterfowl habitat. Wetlands maintenance requires artificial flooding, with most of the water use occurring between August and December and the greatest use occurring in October and November.

D. SAN JOAQUIN RIVER BASIN

1. Geography and Climate

The San Joaquin River Region is located in the heart of California and includes the northern portion of the San Joaquin Valley. It is bordered on the east by the Sierra Nevada and on the west by the coastal mountains of the Diablo Range. It extends from the southern boundaries of the Delta south to include all of the San Joaquin River drainage area. The San Joaquin River Basin is hydrologically separated from the Tulare Lake Basin by a low, broad ridge across the trough of the San Joaquin Valley between the San Joaquin and Kings rivers. Figure III-11 shows the San Joaquin River Basin.

The region is diverse but can be divided into two main topographies and associated climates: (1) the mountain and foothill areas, and (2) the valley area. The climate of much of the upland area west of the valley resembles that of the Sierra foothills. Precipitation in the mountainous areas varies greatly. The annual precipitation of several Sierra Nevada stations averages about 35 inches. Snowmelt runoff from the mountainous areas is the major contributor to local water supplies for the eastern San Joaquin Valley floor. The climate of the valley floor is characterized by long, hot summers and mild winters, and average annual precipitation ranges from 17 inches in the northeast to 9 inches in the south.

2. Population

The population of the San Joaquin River Region in 1990 was about 1.4 million. About 5 percent of the State's population live in this region. From 1980 to 1990, the region's population grew by 41 percent, primarily in Merced, Stanislaus, and San Joaquin counties. Communities such as Stockton, Modesto, Merced, and Tracy, once valley farm centers, are now major regional urban centers. These communities and their smaller neighboring cities, such as Lodi, Galt, Madera, and Manteca, are expected to continue expanding into the mostly agricultural northern San Joaquin Valley. Several counties expect their populations to nearly double by 2010.

Some of the growth in the region is due to the expansion from the San Francisco Bay Area and Sacramento. The relatively inexpensive housing available in the area offsets the long commute to Bay Area jobs for some San Joaquin County residents. Larger cities such as Stockton and Modesto are industrial and commercial centers in their own right.

In contrast to the large valley urban centers, separated by flat agricultural fields and linked by freeways, the foothills are sprinkled with small communities connected by small two-lane roads. Much of the foothill population lives along the old Mother Load route of the 1849 Gold Rush, Highway 49. Towns such as Jackson, Angels Camp, San Andreas,

Sonora, and Oakhurst have grown significantly in the last decade. Off from the north-south trending Highway 49 is a series of roads that lead to Sierra Nevada mountain passes. These mountain roads (Highways 88, 4, 108, and 120) generally follow east-west trending ridges, which are separated by one or more of the nine major river systems draining the Sierra. The economies of mountain communities along these routes depend on tourists and travel industries. These communities are also retirement areas for many former Bay Area and Southern California residents.

The western side of the region, south of Tracy, is sparsely populated. Small farming communities provide services for farms and ranches in the area, all relatively close to Interstate 5, the chief north-south transportation route in California.

3. Land Use

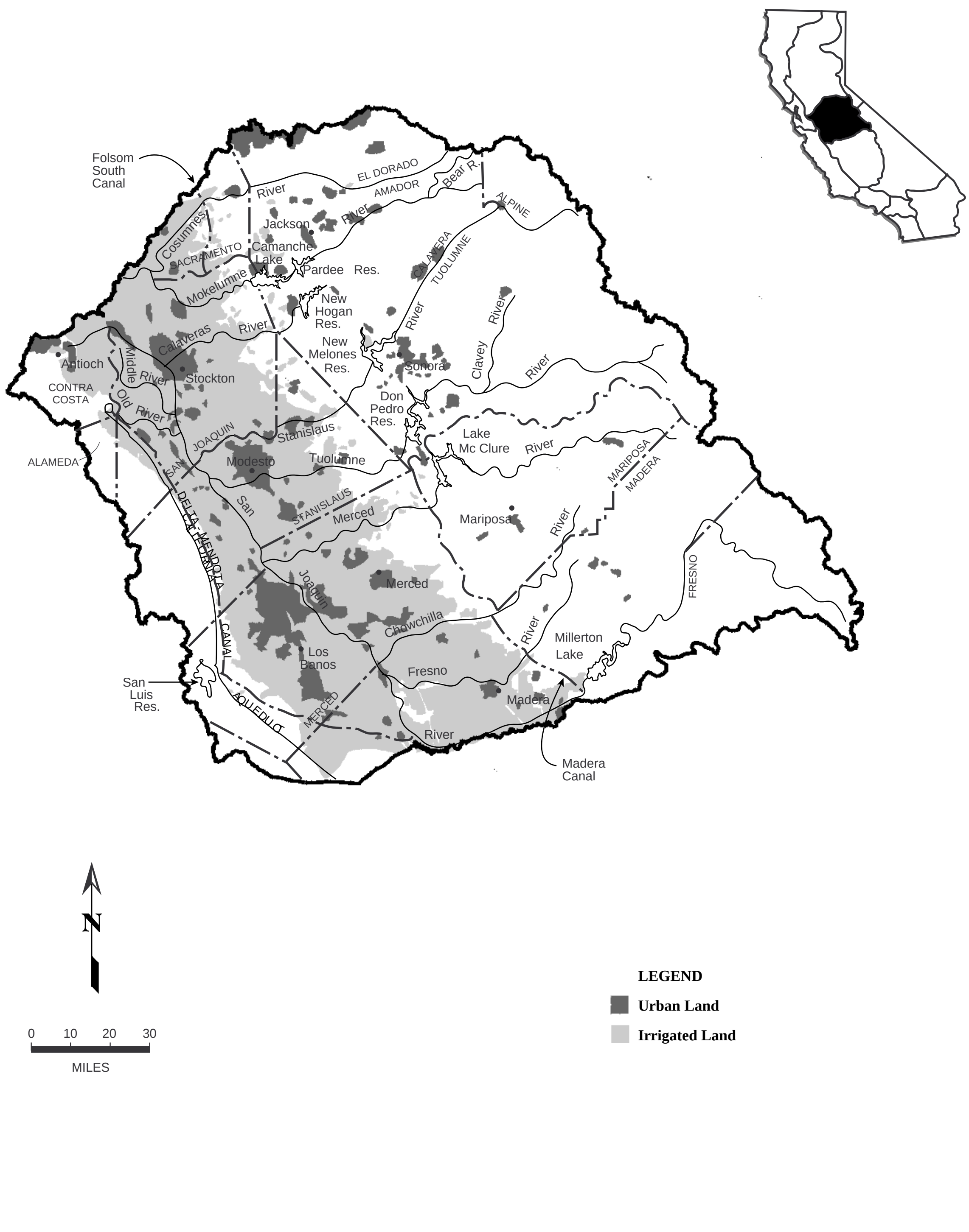
Agriculture is the major economic and land use activity in the San Joaquin River Basin. Other industries in the region include food processing, chemical production, lumber and wood products, glass, textiles, paper, machinery, fabricated metal products and various other commodities.

While the San Joaquin Valley is predominantly privately owned agricultural land, much of the Sierra Nevada is national forest land. The region includes the El Dorado, Stanislaus, and Sierra national forests and the Yosemite National Park. Public lands amount to about one-third of the region. The national forest and park lands encompass over 2,900,000 acres; state parks and recreational areas and other State-owned property account for about 80,000 acres; and BLM and military properties occupy some 221,000 and 37,000 acres, respectively.

The valley portion of the region constitutes about 3,500,000 acres, the eastern foothills and mountains total about 5,800,000 acres, and the western coastal mountains comprise about 900,000 acres. About 1,995,000 (19 percent) of the region's 10,200,000 acres were devoted to irrigated agriculture in 1990.

Irrigated acreage is very diversified with about 30 percent of the acres planted in grains, hay and pasture. Orchards (almonds, pistachios, and other deciduous) and vineyards also make up about 30 percent of the irrigated acres. Some of the other major crops include cotton, corn, tomatoes, and other field and truck crops.

Figure III-11
San Joaquin River Region



Source: DWR, Bulletin 160-93 (1994)

4. Water Supply

About 47 percent of the region's 1990 level average annual water supply comes from local surface sources, while 29 percent is from imported surface supplies. Groundwater provides about 19 percent of the water supply and about 5 percent of the total supply is considered dedicated natural flows for meeting instream flow requirements.

Surface water supply systems in the Sierra streams and rivers form a general pattern. A series of small reservoirs in the mountain valleys gathers and stores snowmelt. This water is used to generate electricity as it is released downstream. Some diversions occur for consumptive use in local communities, but most flows are recaptured in larger reservoirs located in the foothills and along the eastern edge of the valley floor. Most of these reservoirs were built primarily for flood control; however, many of them also have additional storage capacity for water supply and other uses included in their design. Irrigation canals and municipal pipelines divert much of the water from or below these reservoirs.

Most of the small communities in the Sierra foothills receive much of their water from local surface supplies. The extensive network of canals and ditches constructed in the 1850s for hydraulic mining forms the basis of many of the conveyance systems. In addition to surface water, many of these mountain communities pump groundwater from hard rock wells and old mines to augment their supplies, especially during droughts. Groundwater is the only source for many mountain residents who are not connected to a conveyance system.

The major river systems from the Sierra Nevada provide over half of the region's total water supply. Several large irrigation districts deliver most of the local surface water to agricultural users in the valley. Modesto ID and Turlock ID supply both agricultural and municipal users through the Modesto and Turlock Canals. Other irrigation districts, such as Merced, Oakdale and South San Joaquin, operate similar facilities.

Most of the region's imported supplies, about 2 million acre-feet per year, are delivered by the CVP. Oak Flat Water District receives about 5,000 acre-feet per year from the SWP.

a. Surface Water Hydrology. The primary sources of surface water in the San Joaquin River Basin are the rivers that drain the western slope of the Sierra Nevada Mountains. These include the San Joaquin River and its major tributaries, the Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Cosumnes rivers. Most of these rivers drain large areas of high elevation watershed that supply snowmelt runoff during the late spring and early summer months. Other tributaries to the San Joaquin River, including the Chowchilla and Fresno rivers, originate in the Sierra Nevada foothills, where most of the runoff results from rainfall. The three northernmost streams, the Calaveras, Mokelumne, and Cosumnes rivers, flow into the San Joaquin River within the boundaries of the Delta, and are commonly referred to as "eastside tributaries to the Delta."

The mainstem of the San Joaquin River originates on the western slope of the Sierra Nevada at elevations in excess of 10,000 feet. From its source, the river flows southwesterly until it enters the valley floor at Friant. The river then flows westerly to the center of the valley near Mendota, where it turns northwesterly to join the Sacramento River in the Delta. The mainstem of the San Joaquin River has a length of about 300 miles, one-third of which lies above Friant Dam.

Most of the water in the upper San Joaquin River is diverted at Friant Dam, and is conveyed north through the Madera Canal and south through the Friant Kern Canal. Releases from Friant Dam to the San Joaquin River are generally limited to those required to satisfy downstream water rights (above Gravelly Ford) and for flood control. In the vicinity of Gravelly Ford, high channel losses occur because the river bed is primarily sand and gravel. Average annual diversion from the San Joaquin River through the Friant-Kern Canal is 1,149,000 acre-feet.

Due to the operation of Friant Dam, there are seldom any flows in the lower San Joaquin River beyond those flows originating in the major tributaries plus agricultural and municipal return flows. However, prior to construction of Friant Dam, there was at times little or no flow in the San Joaquin River below Sack Dam, due to agricultural diversions and channel losses at Gravelly Ford.

During flood control operations, water that passes Gravelly Ford and exceeds demands at Mendota Pool is diverted from the San Joaquin River to the Chowchilla Bypass, which has a capacity of 6,500 cfs. The Chowchilla Bypass runs northwest, intercepts flows in the Fresno River, and discharges to the Chowchilla River. The Eastside Bypass begins at the Chowchilla River and runs northwesterly to rejoin the San Joaquin River above Fremont Ford. Together, the Chowchilla and Eastside bypasses intercept flows of the San Joaquin, Fresno, and Chowchilla rivers, and other lesser east side San Joaquin River tributaries, to provide flood protection for downstream agricultural lands. The bypasses are located in highly permeable soils, and much of the water goes to recharge of the groundwater basin.

The San Joaquin River tributaries provide the San Joaquin River Basin with high-quality water and most of its surface water supplies. Most of this water is regulated by reservoirs and used on the east side of the valley, but some is diverted across the valley to the Bay Area via the Mokelumne Aqueduct and the Hetch Hetchy Aqueduct. Average annual diversion from the Mokelumne and Tuolumne rivers that are directly exported from the basin include 245,000 acre-feet through the Mokelumne Aqueduct and 267,000 acre-feet through the Hetch-Hetchy Aqueduct.

Dams on the tributary streams include Pardee and Camanche dams on the Mokelumne River, New Melones, Donnells, and Beardsley dams on the Stanislaus River, O'Shaunessy and New Don Pedro dams on the Tuolumne River, and Exchequer Dam on the Merced River. In addition, there are a number of power and irrigation developments on these streams that serve to regulate and modify the natural runoff. A list of the major reservoirs in the San Joaquin River Basin is presented in Table III-13.

Runoff from the watersheds of both the major and minor streams in the San Joaquin River Basin shows wide seasonal, monthly, and daily variations modified by the effects of storage, releases from storage, diversions, and return flows. Stream flows are depleted by diversions and increased by drainage and return irrigation flows along the stream courses.

During the long dry season, the smaller streams often have no flows. Lowest flow conditions usually occur just prior to the advent of the rainy season, usually in late-November.

The San Joaquin River Basin is subjected to two types of floods: those due to prolonged rainstorms during the late-fall and winter, and those due to snowpack melting in the Sierra during the spring and early-summer, particularly during years of heavy snowfall. Major problem areas lie along valleys, foothill streams, and the lower San Joaquin River, where floodflows often exceed channel capacities and damage urban and highly developed agricultural areas.

Streams on the west side of the San Joaquin River Basin include Hospital, Del Puerto, Orestimba, San Luis, and Los Banos creeks. These streams are intermittent and contribute little to water supplies; however, they are an important source of groundwater recharge in local areas.

Table III-13
Major Reservoirs in the San Joaquin River Basin

Reservoir Name	Stream	Capacity (TAF)	Owner
New Melones	Stanislaus River	2,420	USBR
New Don Pedro	Tuolumne River	2,030	Turlock and Modesto IDs
Hetch Hetchy	Tuolumne River	360	City of San Francisco
Lake McClure	Merced River	1,024	Merced ID
San Luis	N/A	2,040	USBR and DWR
Shaver	San Joaquin River	135	Southern California Edison
Pardee	Mokelumne River	210	EBMUD
Salt Springs	Mokelumne River	139	PG&E
Millerton	San Joaquin River	520	USBR
Edison	San Joaquin River	125	Southern California Edison
Lloyd (Cherry)	Tuolumne River	268	City of San Francisco
Mammoth Pool	San Joaquin River	123	Southern California Edison
Camanche	Mokelumne River	431	EBMUD
New Hogan	Calaveras River	325	USCOE
Eastman	Chowchilla River	150	USCOE

Source: DWR 1993b

b. Surface Water Quality. The major water quality problems of streams on the San Joaquin Valley floor are a result of large salt loads from agricultural drainage and nutrients from municipal, industrial, and agricultural sources. The agricultural return water is estimated to carry a total annual salt load of 740,000 tons to the Sacramento-San Joaquin Delta. Salt loads are a problem principally under low flow conditions when adequate dilution water is not available. Although the water in the lower San Joaquin River is still usable for agriculture, severe crop damage has been occasionally experienced when salt concentrations exceed certain threshold limits. Major portions of basin streams are reaching an undesirable state of nutrient enrichment. Prolific aquatic plant and algal growth is causing detriments to beneficial water uses. Aquatic plants have, on occasion, nearly blocked reaches of the lower Stanislaus River and have interfered with recreational uses.

Diurnal fluctuation of dissolved oxygen has contributed to fish kills in the Tuolumne and San Joaquin rivers. The fluctuations are due to the presence of large algal concentrations and partially treated municipal and industrial wastes in the rivers. Other water quality problems include excessive coliform levels, pesticide concentrations, and turbidity.

Generally, water quality in the lower reaches of the San Joaquin River is degraded during summer and fall months of all water years. The poor water quality is due to upstream diversion of the natural flow and from the large volumes of drainage, waste waters, and return flows which, directly or indirectly, find their way into surface streams. The diversion of the natural flow at Friant Dam lessens the ability of the lower San Joaquin River to assimilate the poor quality discharges below Friant Dam. At times, the entire flow in the lower river is comprised of return flows.

Electrical conductivity (EC), boron, and other mineral concentrations are higher in dry and critical years due to a lack of dilution flows. This situation has imposed a slight to moderate degree of restriction on use of river water for irrigation. Among the trace elements analyzed during 1991, a critically dry year, median selenium values frequently exceeded USEPA ambient water quality criteria of 5 micrograms per liter (µg/l) for the protection of aquatic life in the middle portions of the river, and routinely exceeded the primary drinking water standard of 10 µg/l.

Generally, water quality in the Stanislaus, Tuolumne, and Merced rivers is good. Typically, water quality decreases during the late summer as natural flows in the river decrease and poorer quality water such as agricultural return flow increases. The tributary rivers, though contributing freshwater flows year round, do not have sufficient flows during summer and fall months to dilute the poor water quality in the mainstem San Joaquin River.

c. Groundwater Hydrology. The structural basin of the San Joaquin Valley, which contains the San Joaquin River Basin, is deep, asymmetric, and sedimentary. The deepest layers of rock in the structural basin, the crystalline igneous and metamorphic rock and the consolidated marine sedimentary rock, play no significant role in development of the groundwater basin. However, the continental sediments that overlie the marine sediments form the developed part of the groundwater basin. They range in thickness from more than 4,000 feet near the center of the trough to only a few feet along the valley perimeter.

The Mehrten Formation is also of great importance to the fresh groundwater basin of the northern San Joaquin Valley and yields large quantities of water to wells. It is found along the eastern edge of the valley to just south of the Chowchilla River. On the west side of the valley, the upper portion of the Tulare Formation and overlying alluvium constitutes a large portion of the developed groundwater basin.

In general, the top 2000 feet of sediment in the San Joaquin River Region contains fresh water. Beneath the east-side of the region the groundwater system consists of a single semi-confined aquifer. Beneath the western and central part of the region, the Corcoran Clay Member of the Tulare Formation divides the groundwater system into two aquifers: a confined aquifer below the Corcoran Clay and a semi-confined aquifer above the clay. The Corcoran Clay generally is found at depths of 100 to 400 feet, is a maximum of 160 feet thick and extends from the southeastern corner of Contra Costa County to the southern end of the Tulare Lake Basin.

The principal structure controlling the occurrence and movement of groundwater in the San Joaquin River Basin is the structural trough of the San Joaquin Valley. Overall groundwater movement in the basin is from the flanks toward the axis and from there toward the Sacramento-San Joaquin Delta. Secondary structures, such as arches and faults, also influence the occurrence and movement of groundwater. In several areas, groundwater flows toward localized pumping depressions.

The semi-confined aquifer is recharged from stream seepage, deep percolation of rainfall, subsurface inflow along basin boundaries, and with the expansion of irrigated agriculture, deep percolation of applied irrigation water and seepage from distribution and drainage canals. The confined aquifer below the Corcoran Clay is recharged from infiltration of water in areas of the valley where the clay is absent. The confined aquifer also receives water from the overlying semi-confined aquifer transmitted through unsealed well borings drilled through the Corcoran Clay.

DWR has divided this basin into several subbasins including the San Joaquin County, Modesto, Turlock, Merced, Chowchilla, Madera and Delta-Mendota subbasins. Other smaller subbasins exist in the San Joaquin River Region above the valley floor. DWR's most recent estimate of the usable storage capacity of the San Joaquin River Region is approximately 24 million-acre feet. The perennial yield of the region was estimated to be 3.3 million-acre feet. Groundwater pumping was estimated to exceed the perennial yield by approximately 200 thousand-acre feet under normal conditions. Three subbasins in the San Joaquin River Region have been designated by DWR as subject to critical conditions of overdraft: the Eastern San Joaquin County Basin, the Chowchilla Basin and the Madera Basin. Groundwater pumping in the region continues to increase in response to growing urban demand and reduced surface water deliveries from north of the Delta.

Declining groundwater levels have caused land subsidence throughout the part of the region underlain by the Corcoran Clay. The most significant problems have occurred in western Fresno County where land has subsided as much as 30 feet. An area of subsurface drainage problems exists along the western side of the San Joaquin River Basin. Deep percolation of imported water and a decrease in groundwater pumping in this area has resulted in a near- surface water table causing the drainage problem. Toxic trace elements, including selenium, in the drainage water complicates the disposal process. In the lower reaches of the San Joaquin River and near its confluence with major tributaries, high periodic streamflows combined with high groundwater tables have resulted in seepage damage to nearby farmland.

d. Groundwater Quality. Groundwater in the San Joaquin River Basin varies widely in type and concentration of chemical constituents. The differences are related to the quality of water that replenishes the groundwater reservoirs and chemical changes that occur as the water percolates through the soil including cation exchange, sulfate reduction, mineral matter solution, and precipitation of less soluble compounds.

Groundwater quality in the San Joaquin River Basin varies both laterally and vertically. TDS concentrations generally do not exceed 500 mg/l beneath the center and east side of the region due to good quality runoff from the Sierra Nevada. On the west side of the region, TDS concentrations are generally greater than 500 mg/l. At several locations in the region municipal use of groundwater for drinking is impaired due to high TDS, boron, arsenic and nitrate concentrations. High concentrations of dibromochloropropane (DBCP), a nematocide, impairs municipal use of groundwater for drinking near several cities in the region including Chowchilla, Madera, Merced and the Modesto-Turlock area. High boron concentrations also impair agricultural use of groundwater in eastern Stanislaus and Merced Counties. Selenium occurs in concentrations toxic to humans, wildlife and aquatic species in shallow groundwater on the west side of the San Joaquin River Basin. Use of groundwater to support aquatic species is impaired due to high selenium concentration between Los Banos and Mendota in the western part of the region.

5. Water Use

The average annual net water demand in the San Joaquin River Region is about 6.8 million acre-feet. The 1990 level total applied water for the San Joaquin River Region was 7,416,00 acre-feet.

Agricultural water demand represents 85 percent of the total for the region. Total applied water on about 2 million acres of irrigated agricultural land was 6,298,000 acre-feet in 1990. The total evapotranspiration of applied water for those crops was 4,297,000 acre-feet.

Urban demand, which includes residential, industrial, and commercial uses, accounts for 5 percent of the total demand for the region. The 1990 level urban applied water demand for the region was nearly 0.5 million acre-feet and average per capita water use is about 309 gallons per day.

Environmental water use for the region's wetlands and instream fishery requirements makes up 8 percent of the net demand. Wildlife refuges and other wetlands have a net use of 223,000 acre-feet. Four rivers in the region, the Mokelumne, Merced, Stanislaus, and Tuolumne, have significant instream flow requirements. The region's annual water requirement for instream flows is 1,169,000 acre-feet.

Portions of the Tuolumne and Merced rivers are designated wild and scenic under the California Wild and Scenic Rivers Act of 1972 which provides for the preservation of the natural watercourse and character of certain rivers in the State. The upper stretch of the Tuolumne River, below Hetch Hetchy Reservoir and above New Don Pedro Reservoir, was designated wild and scenic in 1984. Much of the Merced River above Lake McClure was given this status in 1987 and the eight-mile stretch from Briceburg to Bagby was added in 1992.

6. Vegetation

Eight common natural community types occur in the San Joaquin River Region occupying approximately 4.9 million acres out of a total land area of 8.3 million acres. The natural communities include mixed conifer forest, montane hardwood, montane riparian, valley foothill hardwood, valley foothill riparian, chaparral, grassland, chenopod scrub, and fresh and saline emergent wetlands. Grassland is the most abundant natural community in this region, with 1.9 million acres mostly on the edges of the valley floor. The largest numbers of special-status plant species are found in this community. Valley foothill woodland is the next most common natural community, occupying 1.3 million acres of the foothill areas of the region.

Historically, the basin contained a large floodplain that supported vast expanses of permanent and seasonal marshes, lakes and riparian areas. Almost 70 percent of the basin has been converted to irrigated agriculture with wetland acreage reduced to 120,300 acres. Even so, the basin contains the largest contiguous block of wetland habitat in the Central Valley. Much of the native vegetation in the San Joaquin River Basin has been replaced by introduced species or disturbed by cultivation or grazing. On the undisturbed portions of the basin, non-native species such as annual grasses and Russian thistle are common, with patches of native vegetation consisting of sagebrush and saltbush.

Sensitive habitats in the San Joaquin River Basin that can be grouped into the valley and foothill riparian community type include: great valley-valley oak riparian forest, great valley cottonwood riparian forest, great valley mixed riparian forest, white alder riparian forest, great valley willow scrub, buttonbush scrub, elderberry savanna, central coast cottonwood-sycamore riparian forest, central coast live oak riparian forest, and central coast arroyo willow riparian forest.

Sensitive grassland communities of the San Joaquin River Basin include vernal pools, valley needlegrass grassland, serpentine bunchgrass, wildflower fields, freshwater seeps, alkali playas, valley sacaton grassland, and pine bluegrass grassland. Three sensitive emergent wetland communities occur in the San Joaquin River Basin: cismontane alkali marsh, coastal and valley freshwater marsh, and vernal marsh. Two types of sensitive chaparral habitats, serpentine chaparral and upper Sonoran subshrub scrub, also occur in the region.

Sycamore alluvial woodland is a sensitive community that occurs on the west side of the San Joaquin Valley. This community type is found along the channels of intermittent streams in which flow is usually produced by rainfall rather than snowmelt. Sycamore alluvial woodland consists of a winter-deciduous broadleafed riparian woodland with widely spaced sycamores, California buckeyes, and elderberry bushes.

Chenopod scrub is a broad community type that includes valley, foothill, and desert habitats. The San Joaquin Valley once contained many examples of the various types of foothill and valley chenopod scrubs, but as a result of flood control, agriculture, and groundwater pumping, distribution of most of these communities is now limited. Chenopod scrub communities consist of shrubby, often succulent species, typically dominated by the Chenopodiaceae family. They occur on poorly drained soils, dry lakebeds, and alluvial fans, often in alkaline or saline soils. Valley sink scrub, valley saltbush scrub, and interior coast range saltbush scrub are particularly sensitive community types. Table III-14 lists the sensitive plant species found in the San Joaquin River Basin.

7. Fish

The San Joaquin River and tributaries provide habitat for a diverse assemblage of fish, both anadromous and resident species. About 45 species of fish are found upstream of the Delta. Of these, 20 are native species. A variety of both coldwater and warmwater fish, including salmonids, striped bass, sunfish, catfish, shad, lampreys, perch, cyprinids, sculpin, and suckers occur in the basin. Table III-15 lists the sensitive fish species occurring in the basin.

Historically, the upper San Joaquin River supported spawning and rearing habitat for the southern-most stocks of spring- and fall-run chinook salmon, and steelhead. Streamflow releases following the construction of Friant Dam are insufficient to support anadromous fish passage, spawning, or rearing. Major reaches of the mainstem river between Gravelly Ford and the confluence with the Merced River are essentially dry for much of the year. During summer and fall, water downstream of Mendota Pool often consists entirely of low-quality agricultural return water. Despite water quality problems, the mainstem river supports a variety of warmwater species, including striped bass, sunfish, catfish, shad, lampreys, perch, cyprinids, sculpin, and suckers. The mainstem river downstream from the confluence with the Merced River also provides a migration corridor for anadromous fish to the Delta and ocean.

Although there are no minimum flow requirements for the mainstem San Joaquin River upstream of Vernalis, there are various requirements for the basin, depending on season, water year type, and water quality standards. These flow requirements can be influenced by the need for maintaining the position of the 2-ppt isohaline (referred to as X2) in the estuary, fishery studies, and temperature needs of anadromous fish.

Table III-14
Sensitive Plant Species in the San Joaquin River Basin

Scientific Name	Common Name	Status: State	Status: CNPS	Status: Federal
Amsinckia grandiflora	Large-flowered fiddleneck	SE	1B	FE
Castilleja campestris ssp. succulenta	Succulent owl's-clover	SE	1B	FT
Caulanthus californicus	California jewelflower	SE	1B	FE
Chamaesyce hooveri	Hoover's spurge		1B	FT
Cordylanthus palmatus	Palmate-bracted bird's-beak	SE	1B	FE
Eriastrum hooveri	Hoover's eriastrum		4	FT
Eryngium racemosum	Delta button-clery	SE	1B	FSC
Gratiola heterosepala	Boggs Lake hedge-hyssop	SE	1B	
Lembertia congdonii	San Joaquin woollythreads		1B	FE
Neostapfia colusana	Colusa grass	SE	1B	FT
Orcuttia inaequalis	San Joaquin Valley Orcutt grass	SE	1B	FT
Orcuttia pilosa	Hairy Orcutt grass	SE	1B	FE
Pseudobahia bahiifolia	Hartweg's golden sunburst	SE	1B	FE
Pseudobahia peirsonii	San Joaquin adobe sunburst	SE	1B	FT
Tuctoria greenei	Greene's tuctoria	SR	1B	FE
Eschscholzia rhombipetala	Diamond petaled poppy		1B	FSC

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
CNPS: (California Native Plant Society) 1A=presumed extinct in California; 1B=rare,threatened, or endangered in California and elsewhere; 2=rare,threatened,or endangered in California but more common elsewhere; 3=need more information; 4=distribution limited (a watchlist).
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

Table III-15
Sensitive Fish Species in the San Joaquin River Basin

Scientific Name	Common Name	Status: State	Status: Federal
Hypomesus transpacificus	Delta smelt	ST	FT
Lampetra hubbsi	Kern Brook lamprey	CSC	FSC
Mylopharodon conocephalus	Hardhead	CSC	
Oncorhynchus tshawytscha	Fall-run chinook salmon, Central Valley, CA ESU		C
Oncorhynchus tshawytscha	Late fall-run chinook salmon, Central Valley, CA ESU	CSC	C
Oncorhynchus mykiss	Steelhead, Central Valley, CA ESU		FT
Pogonichthys macrolepidotus	Sacramento splittail	CSC	FT

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
FEDERAL: FT=threatened; C=candidate for listing; FSC=species of concern.
Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

To meet the requirements of the Central Valley Project Improvement Act, the U.S. Fish and Wildlife Service is developing and implementing the Anadromous Fish Restoration Program (AFRP). The Draft Restoration Plan (May 1997) proposes minimum flows for CVP streams and recommends actions and evaluations for the mainstem San Joaquin River and its tributaries in order to meet the AFRP goal of doubling the natural production of anadromous fish populations in Central Valley streams. For some streams in the basin, Federal Energy Regulatory Commission (FERC) relicensing and water right processes are also underway or planned which may establish instream flow improvements for fisheries.

In March 1995, the U.S. Fish and Wildlife Service issued a Biological Opinion concerning the impacts of the CVP and SWP on delta smelt. This opinion requires interim flows for the San Joaquin River between February and June to be the same as those required in the 1995 Bay/Delta Plan. The USBR and DWR provide these interim flows. The interim flows vary, depending on water year type and the need for positioning X2, and include pulse flows for the transport of juvenile delta smelt from the San Joaquin River to Suisun Bay.

The major eastside tributaries to the San Joaquin River, the Stanislaus, Tuolumne, and Merced rivers, support spawning and rearing habitat for fall-run chinook salmon, late fall-run chinook, and rainbow trout/steelhead. These tributaries also support warmwater game fish populations, such as small and largemouth bass, sunfish, and catfish, and a variety of native fishes, such as hardhead, Sacramento squawfish, Sacramento sucker, sculpin, and lamprey. The Calaveras, Cosumnes, and Mokelumne rivers, tributary to the San Joaquin River in the Delta, support a variety of anadromous and resident species. Fishery resources in the major San Joaquin River tributaries are described in further detail below.

a. <u>Mokelumne River</u>. The lower Mokelumne River supports four species of anadromous fish: fall-run chinook salmon, steelhead, American shad, and striped bass, and a variety of resident species. Fall-run chinook salmon are the most abundant anadromous fish in the river.

Conditions of the aquatic habitat and variation in environmental conditions in the river have resulted in widely varying abundance of these species. Returns of fall-run chinook salmon reached a peak of slightly more than 11,000 in 1983, but declined to fewer than 410 spawners in 1991.

Before the completion of Camanche Dam in 1964, chinook salmon spawned primarily between the town of Clements and the canyon about 3 miles below Pardee Dam. Currently, the majority of salmon spawning occurs in the 5 miles between Camanche Dam and Mackville Road, with 95% of the suitable spawning habitat within 3.5 miles of the dam. As mitigation for the loss of spawning habitat with the construction of the dam, the Mokelumne River Fish Hatchery (MRFH) was constructed, with a capacity to produce 100,000 yearling steelhead and to process 15 million chinook salmon eggs per year. From 1964 to 1988, the MRFH received extremely low numbers of returning adult chinook and steelhead; eggs were imported from other hatcheries to meet production goals.

Prior to completion of Camanche Reservoir, steelhead were the most important sportfish in the lower Mokelumne River based on creel census data. The present natural production of steelhead in the river is thought to be very low.

In 1992, EBMUD prepared a comprehensive management plan for the lower Mokelumne River that included additional instream flows and non-flow enhancement components. In water year 1992, EBMUD voluntarily implemented the basic provisions of the FERC Principles of Agreement (EBMUD, CDFG, USFWS 1996), which included increased flow releases year-round. In recent years, adult chinook salmon returns to the river and hatchery have significantly improved.

b. Stanislaus River. Flow releases for fishery purposes in the lower Stanislaus River are designated in a 1987 agreement between USBR and CDFG. This agreement specifies interim annual flow allocations for fisheries between 98,300 AF and 302,100 AF, depending on carryover storage at New Melones Reservoir and inflow.

Historically, the river supported steelhead and spring- and fall-run chinook salmon. The river now supports fall-run chinook salmon, small numbers of late fall-run chinook and rainbow trout/steelhead, and a variety of resident species. Similar to other tributaries in the basin, fall-run spawning escapements have varied significantly since surveys were initiated in 1939. In the recent drought years (1987 – 1992), returns to the river reached extremely low levels. Since the end of the drought, returns have recovered somewhat.

Fall-run chinook typically begin migration into the river in late September to early October. Elevated water temperatures may delay upstream migration and spawning. Spawning occurs from October through December, typically peaking in November. Fry rearing occurs from January through March. Juveniles emigrate from the river either as fry from January through March, or as smolts from March through June.

c. Tuolumne River. Flow requirements for the lower Tuolumne River are specified in the New Don Pedro Proceeding Settlement Agreement (February 1996) and the FERC License Amendment for the New Don Pedro Project (July 1996). Minimum flows ranging from 94,000 AF to 300,923 AF are provided in the lower Tuolumne River, based on water year type.

Historically, the river supported spring and fall-run chinook salmon and steelhead trout. The river now supports fall-run chinook salmon, small numbers of late fall-run chinook and rainbow trout/steelhead, and a variety of resident species. As in the other San Joaquin River basin tributaries used for spawning, fall-run escapements in the lower Tuolumne River have varied significantly since surveys were initiated in 1939. These population fluctuations are the result of extreme variations in environmental conditions. Since surveys were initiated, the Tuolumne River, on average has supported the highest spawning escapements among the San Joaquin River tributaries.

As in other San Joaquin basin tributaries, spawning returns to the river reached extremely low levels in the recent drought years (1987 – 1992). Since the end of the drought, returns have recovered somewhat.

Fall-run chinook typically begin migration into the river in late September to early October. Elevated water temperatures may delay upstream migration and spawning. Spawning occurs from October through December, typically with a peak in November. Fry rearing occurs from January through March. Juveniles emigrate from the river either as fry from January through March, or as smolts from March through June.

d. Merced River. Streamflows for fishery purposes in the lower Merced River are mandated in FERC License No. 2179 for the New Exchequer Project (April 1964) and the Davis-Grunsky Contract No. D-GG417 between DWR and MID (October 1967). In recent years, water purchases/transfers have been used to supplement streamflows in the lower river.

Historically, the river supported spring and fall-run chinook salmon and perhaps steelhead. The river now supports fall-run chinook salmon, rainbow trout/steelhead, perhaps late fall-run chinook salmon, and a variety of resident fish species. As with the Stanislaus and Tuolumne rivers, the number of late fall-run chinook and rainbow trout/steelhead in the river is unknown. Each year, a few large rainbow trout/steelhead enter the Merced River Hatchery (MRH), but the origin of these fish is unknown.

As with other tributaries in the basin, fall-run chinook salmon escapements in the lower Merced River have varied significantly since surveys were initiated. During the 1987 to 1992 drought, spawning escapement declined to seriously low levels. Since the end of the drought, returns have recovered somewhat.

Merced River Hatchery, located below Crocker-Huffman Dam, is presently the only salmon hatchery in the San Joaquin River drainage south of the Delta. Operated by DFG, the hatchery was constructed in 1970 and operated for 10 years with funding provided in the Davis-Grunsky Agreement. The facility was recently modernized; production capacity was increased to 360,000 yearling salmon and 600,000 salmon smolts and egg production capacity was increased to 4 million.

Fall-run chinook typically begin migration into the river in October, although migration may be delayed due to low instream flows and elevated water temperatures. Spawning occurs from October through December, typically peaking in November. Fry rearing occurs from January through March. Juveniles emigrate from the river either as fry from January through March, or as smolts from March through June.

8. Wildlife

Historically, the San Joaquin Valley was composed of a combination of large seasonal wetlands, extensive grasslands, broad riparian corridors, and vast parcels of desert scrub. The valley supported an exceptionally diverse group of wildlife species, which included bison, elk, and grizzly bears. Agricultural, urban, and commercial development have reduced, fragmented, and heavily modified natural habitat on the valley floor; only about 5 to 10 percent of its historical habitats remain.

Although few large mammals remain in the San Joaquin Valley, the remnant habitat continues to support a diverse group of species. Coyotes, gray foxes, kit foxes, badgers, skunks, and opossums feed on the many species of rodents, rabbits, reptiles, and insects on the valley floor. California and antelope ground squirrels make up the majority of large terrestrial rodents, while beaver and muskrat represent semi-aquatic species.

Millions of waterfowl associated with the Pacific Flyway overwinter in the valley wetlands. Raptor species, including bald eagles, prairie falcons, and great-horned owls, hunt in the wetlands, grasslands, and riparian habitats of the San Joaquin Valley. Many passerines, including species of flycatchers, swallows, warblers, blackbirds, and sparrows, nest and/or overwinter in the variety of habitats associated with the San Joaquin River Basin. Upland game birds include dove, pheasant, chukar, and quail; shorebirds include multiple species of gulls, terns, plovers, sandpipers, and egrets.

Herptiles of the area include garter, gopher, night, and king snakes; western pond turtles; leopard, fence, alligator, and side-blotched lizards; skinks and whiptails; red-legged, yellow-legged, tree, and bull frogs; and tiger and slender salamanders. As with other diverse habitats, the San Joaquin River Basin is home to thousands of insect and other invertebrate species.

The loss of the majority of natural habitat in the valley, and its subsequent replacement by urban and agricultural monocultures, resulted in the decline of many of the valley's species, some to near extinction. Although conservation agencies have succeeded in slowing the habitat loss trends, many species continue to struggle for survival. Table III-16 lists the sensitive wildlife species found in the San Joaquin River Basin.

A total of 77 significant natural areas are scattered throughout the San Joaquin River Basin. These SNAs are important to waterfowl and shore birds that winter and nest in the San Joaquin River Basin, as well as for many special-status species.

Food and cover for native wildlife are limited throughout much of the valley. The hot, dry climate of the west side of the San Joaquin Valley limits vegetation on the valley floor mostly to sagebrush, tumbleweed, and some grasses, except in a few draws and creek channels. The foothills of the Coast Ranges are also dry and mostly treeless except in a few creek bottoms. Some wildlife cover plantings along the San Luis Canal have provided additional wildlife habitat.

In the trough of the San Joaquin Valley between Mendota and Gustine are tens of thousands of acres of excellent waterfowl land which constitute an important station along the Pacific Flyway. Drainage flows were previously an appreciable percentage of the water supply for this area and were used to grow feed and cover crops, and to provide resting ponds for the waterfowl using this area. While drainage seemed to be an attractive source of water for wetland use, selenium levels in the drainage water became toxic to waterfowl. The Grasslands Water District no longer accepts tile drainage flows in the Grasslands area for wetland use. Since passage of the CVPIA, water for these wetlands has been made available from the Delta-Mendota Canal or tailwater supplies. Selenium remains a concern because the Grasslands area has a significant accumulation of these salts from local tributary streams and the residues from past use of tile drain water.

9. Recreation

Key recreation areas in the San Joaquin River Region are Millerton Lake, San Luis Reservoir, New Melones Reservoir, Lake McClure, New Don Pedro Reservoir, and the San Joaquin, Merced, Tuolumne, and Stanislaus rivers. Key federal and State wildlife refuges that provide opportunities for hunting waterfowl and upland game are the San Luis, Merced, and Kern NWRs and the Volta and Los Banos WMAs. Waterfowl and upland game hunting on private lands is also described in this section. Other potentially affected recreation areas include Bethany Reservoir, O'Neill Forebay, New Hogan Lake, and Camanche Reservoir; the Mokelumne and Calaveras Rivers; and the California Aqueduct and Delta-Mendota Canal.

a. Reservoirs. Recreation opportunities in the San Joaquin River Basin have been shaped substantially by the construction of dams and creation of large lakes on the San Joaquin River and all of its major tributaries. Between 1945 and 1970, flatwater recreation opportunities in the San Joaquin River Region became more extensive as lakes, reservoirs, and recreation facilities were constructed. Between 1945 and the mid-1960s, Millerton Lake provided most of the flatwater recreation opportunities in the region. In 1970, the combined annual recreation use at San Luis Reservoir and Millerton Lake totaled approximately 678,000 visitor-days, increasing to approximately 1.6 million visitor days in 1980 with the addition of New Melones Reservoir.

San Luis Reservoir. The San Luis Reservoir SRA, operated by DPR, covers approximately 12,700 surface acres when full. Major components of the San Luis Reservoir SRA are the recreation facilities that accommodate boating, water-skiing, fishing, picnicking, camping, hunting, and trail use activities. Boat access is provided in the southeastern portion of the reservoir at the Basalt area, a two-lane concrete boat ramp and boarding dock, and at the northwestern Dinosaur Point use area, which features a four-lane concrete boat ramp and boarding dock.

Boat and shore fishing occurs throughout San Luis Reservoir. Striped bass is the primary game fish in the reservoir. Fishing is usually of high quality from late February through summer, with striped bass fishing best during winter and spring.

Table III-16
Sensitive Wildlife Species in the San Joaquin River Basin

Scientific Name	Common Name	Status State	Status Federal
Agelaius tricolor	Tricolored blackbird	CSC	FSC
Branta canadensis leucopareia	Aleutian Canada goose		FT
Buteo swainsoni	Swainson's hawk	ST	
Empidonax traillii	Willow flycatcher	SE	
Grus canadensis tabida	Greater sandhill crane	ST	
Haliaeetus leucocephalus	Bald eagle	SE	FT
Plegadis chihi	White-faced ibis	CSC	FSC
Vireo bellii pusillus	Least Bell's vireo	SE	
Ammospermophilus nelsoni	San Joaquin antelope squirrel	ST	FSC
Antrozous pallidus	Pallid bat	CSC	
Corynorhinus townsendii townsendii	Townsend's western big-eared bat	CSC	
Dipodomys ingens	Giant kangaroo rat	SE	FE
Dipodomys nitratoides exilis	Fresno kangaroo rat	SE	FE
Euderma maculatum	Spotted bat	CSC	FSC
Eumops perotis californicus	California mastiff bat	CSC	FSC
Myotis ciliolabrum	Western small-footed myotis		FSC
Myotis evotis	Long-eared myotis		FSC
Myotis volans	Long-legged myotis		FSC
Myotis yumanensis	Yuma myotis		FSC
Neotoma fuscipes riparia	Riparian woodrat	CSC	FPE
Sylvilagus bachmani riparius	Riparian brush rabbit	SE	FPE
Vulpes macrotis mutica	San Joaquin kit fox	ST	FE
Rana aurora draytonii	California red-legged frog		FT
Clemmys marmorata	Western pond turtle		
Gambelia sila	Blunt-nosed leopard lizard	SE	FE
Thamnophis gigas	Giant garter snake	ST	FT
Branchinecta conservatio	Conservancy fairy shrimp		FE
Branchinecta longiantenna	Longhorn fairy shrimp		FE
Branchinecta lynchi	Vernal pool fairy shrimp		FT
Desmocerus californicus dimorphus	Valley elderberry longhorn beetle		FT

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

Wind conditions on the reservoir can create hazardous boating conditions. Warning lights at the DWR-operated Romero Overlook visitor center and DPR Quien Sabe Point facility indicate when wind conditions on the reservoir are hazardous. San Luis Reservoir has no designated swimming or lakeside beach areas. Water-skiing is allowed in designated areas around the 65-mile reservoir shoreline.

Migratory waterfowl hunting is permitted on most of the reservoir at approximately 300 feet from established reservoir and recreation facilities. Hunting for deer and wild pig is also allowed in the San Luis Reservoir SRA on the northwestern reservoir shoreline. Recreation use at San Luis Reservoir is optimized at a maximum reservoir pool elevation of 544 feet above msl. Use of the Basalt area boat ramp becomes inconvenient at approximately 340 feet above msl, but it can be used on a limited basis. The four-lane boat ramp at Dinosaur Point can be used at the minimum reservoir pool but is difficult to access below 360 feet above msl. Swimming activities are not affected by reservoir surface water fluctuations because the reservoir has no designated swimming facilities.

Millerton Lake. Recreation facilities at Millerton Lake are operated by DPR as part of the Millerton Lake SRA. When full, the lake has a surface area of 4,920 acres, 51 miles of shoreline, and a surface elevation of 537 feet above msl.

Recreation opportunities at Millerton Lake include fishing, swimming, boating, water-skiing, picnicking, camping, and trail use. Boat access is provided on the south and north shores of the lake. Major use areas are the La Playa, Grange Grove, Blue Oak, and South Bay picnic areas; McKenzie Point boat ramp and swimming area; and Winchell Bay Marina and South Finegold picnic area on the south shore. Five boat ramps located along the south shore provide 33 launching lanes. The north shore features camping facilities at Dumna Cove and a two-lane boat ramp at the Meadow Campground. The Winchell Bay Marina provides up to 450 berthing slips.

Fishing occurs from boats and the shore throughout the reservoir. The Millerton Lake fishery consists of trout and warmwater species. The warmwater fishery includes a popular inland striped bass program along with spotted and largemouth bass. It is a popular lake for bass tournaments. Swimming and sunbathing are popular at the La Playa and South Bay picnic areas from May through September. Boating and water-skiing are popular throughout the main southern reservoir areas. Northwest of Finegold Bay, the 16-mile San Joaquin River Canyon portion of the reservoir is designated as a no-skiing area with a 35-mile-per-hour (mph) boat speed limit. A 5-mph boat speed limit is enforced at the Temperance Flat boat and environmental camps.

Millerton Lake is a popular recreation destination for Fresno, Madera, and Merced county residents and regularly sustains heavy use during the peak summer season. In 1992, use at the Millerton Lake SRA totaled approximately 948,000 visitor days.

Despite the availability of usable boat ramps year-round, Millerton Lake recreation use decreases substantially when the reservoir drops to an elevation of 468 feet above msl. Boat Ramps No. 1

(La Playa) and 6 (Meadow Camp) can be used at all surface water elevations. Ramp No. 2 can be used between elevations 520 and 537 feet above msl; Ramp No. 3 at elevations above the normal maximum pool from 537 to 578 feet above msl; Ramp No. 4 at surface water elevations of 500 to 520 feet above msl; and Ramp No. 5 at elevations 468 to 500 feet above msl.

Winchell Bay Marina operations are affected by changes of approximately 3 feet in surface water elevation. Although the marina must be moved frequently when the lake fluctuates, it is operable at all surface water elevations.

The south shore swimming areas are also affected by changes in reservoir water elevations. The La Playa swimming area is generally used at high water elevations, and the McKenzie Point swimming area is generally used at low water elevations. Camping at most of the lake units is not affected by water elevations, except for the Temperance Flat camping unit, which cannot be used below 520 feet above msl.

New Melones Reservoir. Recreation facilities at New Melones Reservoir have operated since 1979 when initial recreation development was completed. When full, the reservoir has a surface area of approximately 3,600 acres, 105 miles of shoreline, and a surface elevation of 1,088 feet above msl.

Recreation facilities at the reservoir accommodate swimming, boating, water-skiing, fishing, picnicking, and camping. Boat access is provided on the north and east shores of the reservoir. Developed use areas are the Glory Hole recreation area in the northwestern portion of the reservoir and the Tuttletown recreation area on the eastern shore. The Mark Twain, Parrot's Ferry, Camp Nine, and Old Town recreation areas are undeveloped and offer minimal facilities.

The Glory Hole recreation area is the most intensively used facility on the reservoir and features three boat ramps (seven-lane) used for high, medium, and low reservoir levels; a concession-operated marina with berthing slips; three courtesy docks; picnic sites; and camping facilities. A developed beach area provides swimming opportunities.

The Tuttletown recreation area features three seven-lane boat ramps used for variable reservoir levels, three courtesy docks, a fish-cleaning station, picnic sites, and camping facilities. The designated swimming area and beach at Angels Arm recreation area is closed. Boating and water-skiing are popular throughout the main reservoir area, and fishing is popular from boats and the shoreline.

Approximately 1,495,000 visitor days at New Melones Reservoir were recorded in 1992. Water-dependent recreation activities, which account for the largest portion of annual visitation, include water-skiing, pleasure boating, and fishing. Camping is the most popular water-enhanced activity. The optimal reservoir level for recreation use is at an elevation of approximately 950 to 980 feet above msl. All boat ramps except one at Glory Hole cease operation as the lake reaches a surface elevation of 950 feet above msl. The Glory Hole boat ramp is a 2-lane facility constructed by volunteers to provide boat access at a reservoir elevation as low as 860 feet above msl. The Glory Hole Marina must be moved with changing water levels. At an approximate elevation of 900 to 950 feet above msl, use is substantially reduced by loss of all but the Glory Hole boat ramp. At an elevation of 880 feet above msl, which was reached during the recent drought, the marina closes. Other ramps in the Mark Twain, Parrot's Ferry, and Old Town undeveloped recreation areas are old roads that can be used on a limited basis to an elevation of approximately 850 feet above msl.

Lake McClure. Lake McClure is owned and operated by the Merced ID. When full, the lake has a surface area of 7,100 acres, 80 miles of shoreline, and an elevation of 867 feet above msl. Recreation facilities at Lake McClure accommodate a wide variety of water-dependent and water-enhanced activities. Boat access is provided at ramps located around the shoreline. The four major use areas are McClure Point and Barrett Cove recreation areas on the western shoreline, Horseshoe Bend recreation area on the northern shoreline, and Bagby recreation area at the SR 49 crossing on the eastern reservoir arm.

McClure Point facilities include 3 boat launch lanes, a swimming lagoon, a marina with a store and houseboat mooring, picnic areas, comfort stations, and 100 camping units. Barrett Cove features 2 boat ramps with a total of 5 lanes, a swimming lagoon, a marina, comfort stations, picnic areas, and 275 camping units. The Horseshoe Bend recreation area features a 2-lane boat ramp, a swimming lagoon, picnic areas, and 110 camping units. The Bagby recreation area provides a 1-lane boat ramp, marina, picnic area, and 25 camping units. Each use area has a concession store.

Approximately 606,000 visitor days were recorded at Lake McClure in 1992. Day-use activities accounted for most of the visitor days. Recreation activities include boating, water-skiing, fishing, swimming, sailing, jet skiing, hang gliding, picnicking, and camping. Boating and water-skiing occur throughout the reservoir. Year-round planting enhances rainbow trout fishing opportunities from boat and the shoreline. Bass fishing has improved since the Florida largemouth bass was introduced. Swimming areas are provided at three developed lagoons that feature beach and picnic areas.

The Lake McClure boat ramps cease operation between 590 and 793 feet above msl. The Bagby ramp is the first to cease operation at 793 feet above msl, followed by Horseshoe Bend at 758 feet above msl; McClure Point at 650 feet above msl; southern Barrett Cove ramp at 630 feet above msl; and northern Barrett Cove and Piney Creek, both at 590 feet above msl. The Horseshoe Bend and Bagby ramps were the only facilities affected during the peak summer recreation season under drought conditions in 1992.

New Don Pedro Reservoir. New Don Pedro Reservoir is owned and operated by the Modesto ID and the Turlock ID. The Don Pedro Recreation Agency operates recreation facilities. When full, the reservoir has a surface area of 13,000 acres, 160 miles of shoreline, and a maximum water surface elevation of 830 feet above msl.

Recreation facilities at the reservoir accommodate water-dependent and water-enhanced activities. The developed use areas are Fleming Meadows recreation area on the southern shoreline, Blue Oaks recreation area on the southwestern shoreline, and Moccasin Point recreation area on the northeastern arm of Moccasin Bay, all with boat launch facilities. Two full-service marinas featuring docks, boat slips, mooring areas, and provisions are provided at Fleming Meadows and Moccasin Point recreation areas. A 2-acre swimming lagoon at Fleming Meadows is separated from the main reservoir body and includes a swimming area with a maximum depth of 6 feet, picnic facilities, and a sandy beach area. Camping facilities consist of 550 sites for the 3 recreation areas. Primitive boat-in camping is allowed throughout the 160-mile shoreline.

Recreation activities include boating, swimming, water-skiing, jet skiing, windsurfing, sailing, houseboating, fishing, camping, boat-in camping, picnicking, and sightseeing. Boating and water-skiing occur throughout the reservoir. Swimming occurs mainly at the Fleming Meadows swimming lagoon. Shore and boat fishing is mainly for bass, trout, salmon, crappie, bluegill, and catfish.

Use at New Don Pedro Reservoir totaled approximately 419,000 visitor days in 1992. Water-dependent recreation, such as boating, water-skiing, fishing, and camping account for most of the annual visitation.

The full pool elevation for New Don Pedro Reservoir is 830 feet above msl. Generally, use of the reservoir declines moderately when the elevation reaches 790 feet above msl and considerably at 750 feet above msl. The Fleming Meadows boat ramp is out of operation at elevation 600 feet above msl (minimum pool). Between 710 feet and minimum pool, five ramps are lost. The Moccasin Point boat ramp cannot be used at an elevation of 722 feet above msl, and the Blue Oaks boat ramp cannot be used at 726 feet above msl. The Fleming Meadows and Moccasin Point marina operations are limited at 600 and 630 feet above msl, respectively. The swimming lagoon is used at all reservoir surface water elevations because it is separated from the main reservoir and water levels are maintained by pumping water from the reservoir to the lagoon.

Bethany Reservoir. The 160-acre Bethany Reservoir is located on the California Aqueduct just south of the Delta pumping plants in Alameda County. DPR operates the recreation facilities at the reservoir. The reservoir functions as a forebay for the South Bay Pumping Plant and a balancing pool for discharge from the Harvey O. Banks Pumping Plant.

Recreation facilities provide opportunities for fishing, boating, windsurfing, picnicking, hiking, and bicycling. Boat access is provided at a two-lane boat ramp on the northern shoreline near the main reservoir access point. Picnic areas are provided on the northern and southern shorelines; a bicycle path along the northern shoreline connects the picnic areas.

Fishing is the most popular activity at Bethany Reservoir, and striped bass and catfish are the species most often caught. Boating is allowed on Bethany Reservoir, however, although boat sizes are not limited, maximum speeds are limited to 15 mph in open water and 5 mph within 200 feet of the shore. Strong winds at the reservoir provide windsurfing opportunities.

Approximately 30,000 visitor days were recorded at Bethany Reservoir in 1991. Because Bethany Reservoir functions as a forebay and regulating reservoir on the California Aqueduct, its water surface elevation does not fluctuate substantially.

O'Neill Forebay. Recreation facilities at the 2,700-acre O'Neill Forebay supplement recreation opportunities provided on San Luis Reservoir. Recreation facilities include the Medeiros recreation area, which provides picnicking, camping, and boat ramp access, and the San Luis Creek day-use area, which provides picnicking, swimming, and boat ramp access.

Approximately 1,250,000 visitor days at O'Neill Forebay were estimated in 1992. Recreation facilities provide more diverse recreation opportunities at the forebay than at San Luis Reservoir. Windsurfing, swimming, wading, and relaxing are the most popular activities at the forebay.

Recreation use at O'Neill Forebay generally is not affected by water level fluctuations because, as with Bethany Reservoir, surface water elevations at these control reservoirs are usually maintained at constant levels. DWR tries to maintain high water surface elevations as operational needs allow at O'Neill Forebay to provide a safe windsurfing area. If water levels were to fluctuate greatly, beach use would probably be adversely affected because a minor drop in surface elevation would expose a relatively large amount of the forebay shoreline.

New Hogan Lake. New Hogan Lake is located on the Calaveras River and is operated by the USCOE. When full, the lake has a surface area of approximately 4,400 acres, 50 miles of shoreline, and a surface elevation of 713 feet above msl. Recreation facilities at New Hogan Lake provide opportunities for a wide variety of water-dependent activities, such as boating, water-skiing, fishing, swimming, and boat-in camping.

Boat access is available at Fiddleneck day-use area and Acorn East Campground. Major day- and overnight-use areas along the shoreline are primarily concentrated on the western and northern shoreline and include the Monte Vista picnic and trail use area, Wrinkle Cove picnic and swimming area, Acorn West and East campgrounds, Coyote Point Campground, and Fiddleneck day-use area. The Deer Flat boat-in camp is located on the southeastern shore. Shoreline fishing access is provided at the Bear Creek and Whiskey Creek access points on the southern shoreline and at major use areas on the western and northern shore. The New Hogan Marina at the south end of the Fiddleneck day-use area offers boating and fishing supplies, 80 to 90 berthing slips, and boat storage facilities.

Boating and water-skiing are popular lake activities during summer. Jet skiing is becoming increasingly popular at the lake, particularly during optimal water level periods. Boating speeds are restricted to 5 mph in most of the southern and western shoreline coves. Wrinkle Cove is a popular swimming area where boats are prohibited.

Fishing occurs from boats and the shore throughout the lake. According to a DFG creel census, naturally reproducing striped bass are plentiful in New Hogan Lake, although recent creel census data show a decline in fishing conditions during the 1988-1992 drought. Black bass, crappie, sunfish/bluegill, and catfish are caught regularly.

In 1992, use at the lake totaled approximately 555,000 visitor days. Water-dependent recreation activities (e.g., boating, water-skiing, swimming, and fishing) accounted for a large proportion of this use. Average reservoir pool elevation at the beginning of the recreation season is 680 feet above msl. The reservoir pool elevation for the average recreation season (April-September) is 665 feet above msl.

Lake levels that fall below normal or average levels adversely affect recreation at New Hogan Lake. Although extreme high water inundates some day-use and camping facilities, the quality of recreation is not substantially affected by high water. When lake levels are at or above normal levels, hazards and visually unappealing shorelines are not exposed. Recreation use is high during this period because a large amount of water surface is available and the shoreline is safely accessible.

Boat Ramps Nos. 1, 2, and 3 at the Fiddleneck day-use area cannot be used at elevations 575, 650, and 673 feet above msl, respectively. The Acorn East Campground ramp cannot be used at an elevation of 662 feet above msl. The New Hogan Marina must move facilities frequently during the summer recreation season. Low water levels greatly affect marina operation and business. Use of picnic facilities is usually not substantially affected by water levels, but campground use is greatly affected by low water levels in all of the New Hogan Lake facilities because access to lakeside camping facilities is reduced.

Camanche Reservoir. Camanche Reservoir, a 7,700-acre reservoir with 53 miles of shoreline, is owned and operated by EBMUD. Recreation facilities include 15,000 acres of recreation lands, 2 main recreation areas with tent and RV camp sites, 2 marinas, 3 paved boat ramps with a total of 17 lanes, cottages, tennis courts, riding stables, conference rooms, a general store, a coffee shop, and an amphitheater. The north and south shore marinas are full-service facilities featuring boat slips, boat rentals, and bait and tackle.

Water-dependent recreation activities are swimming, water-skiing, jet skiing, windsurfing and fishing year-round. Water-skiing is restricted in the upper reservoir arms. Fishing occurs for cold- and warm-water species such as rainbow and brown trout, channel and white catfish, sunfish, crappie, largemouth and smallmouth bass, spotted black bass, and white sturgeon.

Approximately 387,000 total visitor days were recorded at Camanche Reservoir's north and south shore recreation areas in 1992. Water-dependent recreation activities dominate reservoir use. In 1992, overnight use was greater than day use.

At full pool, the Camanche Reservoir surface water elevation is 235 feet above msl. One of the south shore boat ramps is operational at elevation 180 feet above msl to full pool. The second south shore boat ramp is operational at 170 to 180 feet above msl. The north shore boat ramp is operational at elevation 205 to 235 feet above msl and at elevation 160 to 190 feet above msl.

b. **Rivers**. Construction and operation of the lakes and reservoirs that provide flatwater recreation opportunities have substantially affected instream uses below them. Sport fisheries in rivers below major lakes and reservoirs have substantially declined. As upstream spawning areas have been lost and water has been diverted, salmon and steelhead populations have declined.

San Joaquin River. The lower San Joaquin River is more than 100 miles long from Millerton Lake to the Sacramento-San Joaquin Delta. Recreational development on the San Joaquin River below Friant Dam has been expanding in recent years with the creation of the San Joaquin River Conservancy, a state-established regional land conservancy. Recent parkway developments in the Fresno area include Lost Lake Park and the Lewis Moran Bicycle Trail. The river borders the Madera/Fresno county line from Millerton Lake to the Merced County line near the SR 152 crossing. Public access is available along this reach at several road and state highway crossings. The river borders the San Luis NWR and crosses the Fremont Ford SRA in Merced County. Stanislaus County recreation facilities include the Las Palmas fishing access site, Laird County Park, and numerous public access points. Recreation facilities on the river in San Joaquin County are Durham Ferry SRA, Mossdale Landing County Park, Dos Reis County Park, and numerous public road crossings. The City of Stockton has three recreation facilities on the Stockton Deep Water Channel. The Buckley Cove Marina is located on the San Joaquin River east of Stockton.

Merced River. The Merced River below McSwain Dam is a 50-mile-long reach that crosses private agricultural and grazing land in Merced County enroute to its confluence with the San Joaquin River at the Merced/Stanislaus county line. Major public recreation facilities on the river are Henderson County Park on Merced Falls Road east of Snelling, McConnell SRA northeast of Livingston on SR 99, Hagaman County Park at the SR 165 river crossing, and George J. Hatfield SRA on Kelley Road near the San Joaquin River confluence. County parks provide primarily day-use facilities, and State recreation areas provide day-use facilities and camping units.

The two county parks offer group picnic areas and softball fields. No swimming or other water contact activities are allowed at either park because lifeguards are not provided. No boat ramps are provided at the county parks, and boating use is generally low because the river is shallow as most of the flow is diverted upstream. Some canoeing and rafting occurs on the lower river.

Tuolumne River. The Tuolumne River below New Don Pedro Reservoir extends approximately 50 miles to its confluence with the San Joaquin River, traversing mainly private open space and grazing lands, property within the City of Modesto, and several public parks. Major recreation facilities are the La Grange County Regional Park on Yosemite Boulevard near La Grange, Turlock Lake SRA located on Lake Road between Turlock Lake and the river, Fox Grove Regional County Park near the Greer Road/Albers Road crossing, two golf courses adjacent to the river near the SR 99 crossing, and the Shiloh fishing access site at the Shiloh Road crossing upstream of the San Joaquin River/Tuolumne River confluence.

Recreation use on the lower Tuolumne River consists of primarily water-dependent activities, such as fishing, swimming, canoeing, rafting, and water-enhanced activities at picnic areas and campgrounds.

Stanislaus River. The reach of Stanislaus River between New Melones Reservoir and its confluence with the San Joaquin River is 60 miles long. The river traverses primarily private agricultural and grazing lands in Tuolumne, Stanislaus, and San Joaquin counties. It borders the Stanislaus/San Joaquin county line approximately 4 miles downstream from Oakdale. A number of developed and undeveloped public parks are located along the lower Stanislaus River. Caswell Memorial State Park is approximately 3 miles upstream of the Sacramento/San Joaquin river confluence; this public facility features day-use facilities and a campground. Public access to the river is dispersed at numerous road crossings. Access for a whitewater rafting run is provided just below Goodwin Dam. The 4-mile-long whitewater run between Goodwin Dam and Knights Ferry is rated Class II-VI (advanced) with several difficult portages. Other river activities include fishing, swimming, picnicking, and camping.

Mokelumne River. The lower Mokelumne River is a 29.6-mile-long segment of the river between Camanche Reservoir and the Sacramento/San Joaquin Delta. Most of the lower Mokelumne River traverses private rural lands. Major public recreation facilities on the river are EBMUD's Mokelumne River Day Use Area located on McIntire Road near Camanche Reservoir, Stillman McGee County Park on Mackville Road near Clementes, and Lake Lodi near the community of Woodbridge. Public access to the Mokelumne River is available at numerous road crossings in and around Lodi.

Recreation facilities at the Mokelumne River Day Use Area consist of parking, picnic areas, portable toilets, and river access. No boat launch facilities are provided in this recreation area. Popular recreation activities include fishing, wading, swimming, canoeing, kayaking, tubing, and picnicking.

Calaveras River. The Calaveras River below New Hogan Lake is 45 miles long and crosses primarily private land in Calaveras and San Joaquin counties enroute to its confluence with the San Joaquin River at the Stockton Deep Water Channel. In Stockton, the river crosses several roads that provide public access. The only public recreation facilities immediately adjacent to river are the Stockton Golf and Country Club and the Brookside Community Golf Course; both are located near the confluence with the San Joaquin River. The Buckley Cove Marina is located immediately downstream of the confluence. The marina consists of approximately 47 acres devoted to boat launching, parking, and marina uses and 5 acres for picnicking, a tot-lot play area, and shore fishing access. Activities include some small-craft boating, fishing, swimming, and wading.

c. **Conveyance Facilities**. Fishing is popular along many of the canals in the area. Public access is provided on the California Aqueduct and the Delta-Mendota Canal.

California Aqueduct. Fishing access is provided along much of the California Aqueduct, stretching from Bethany Reservoir west of Tracy to Silverwood Lake in Southern California. Most of the portion of the aqueduct that passes through the San Joaquin River Region has walk-in access for fishing. There are 11 fishing access sites which provide parking and toilet facilities. In addition, there are also 97 miles of bikeways along the Aqueduct.

A stock of many kinds of fish has developed from fish and eggs surviving the CVP and SWP pumps. Fish species caught in the aqueduct include striped bass, largemouth bass, catfish, crappie, green sunfish, bluegill and starry flounder.

Delta-Mendota Canal. Fishing access to the Delta-Mendota Canal is provided at Delta-Mendota Canal Site 2A in Stanislaus County and Delta-Mendota Canal Site 5 in Fresno County. Canal Site 2A, covering 87 acres, includes a parking area and restrooms. Canal Site 5, covering 570 acres, also includes parking areas and restrooms. Neither site provides picnicking or camping facilities. Fishing access to the Delta-Mendota Canal is limited to the developed access points.

Fishing is the primary activity at both access sites. Fish species most frequently caught at the access sites are striped bass and catfish.

d. **Wildlife Refuges**. Recreation activities at the federal wildlife refuges and State Wildlife Management Areas which receive surface water diversions could be affected by the proposed actions. Wildlife refuges in the San Joaquin River Region include the San Luis and Merced NWRs and Volta and Los Banos WMAs.

Most recreation activities on the refuges are associated with the presence of waterfowl and upland game birds. These activities include hunting, hiking, and wildlife observation. Hunting of ducks, geese, and pheasants is permitted between October and January on portions of each refuge. Fishing is permitted at San Luis NWR only. Recreation facilities are limited at San Luis and Merced NWRs; however, both refuges provide self-guided tours. Camping is permitted at staging areas on the NWRs during hunting season only. Camping is not permitted at the Volta or Los Banos WMA.

e. **Private Hunting Clubs**. There are some 176 private hunting clubs in the San Joaquin River Basin encompassing approximately 96,800 acres. Approximately 33,900 acres are flooded annually and much of the water comes from surface water diversions. These private clubs provide opportunities for hunting ducks, geese, and pheasants.

E. SACRAMENTO-SAN JOAQUIN DELTA

1. Geography and Climate

The Sacramento-San Joaquin Delta area forms the lowest part of the Central Valley, bordering and lying between the Sacramento and San Joaquin rivers and extending from the confluence of these rivers inland as far as Sacramento and Stockton.

The Delta, which has legal boundaries established in California Water Code Section 12220 (Figure III-12), comprises a 738,000-acre area generally bordered by the cities of Sacramento, Stockton, Tracy, and Pittsburg. This former wetland area has been reclaimed into more than 60 islands and tracts which are devoted primarily to farming. The Delta is interlaced with about 700 miles of waterways. A network of levees protects the islands and tracts, most of which lie near or below sea level, from flooding. Prior to development, which began in the mid-19th century, the Delta was mainly tule marsh and grassland, with some high spots rising to a maximum of about 10 to 15 feet above mean sea level. The low dikes of early Delta farmers became a system of levees that now protect about 520,000 acres of farmland. There are now about 1,100 miles of levees, some standing 25 feet high and reaching 200 feet across at the base.

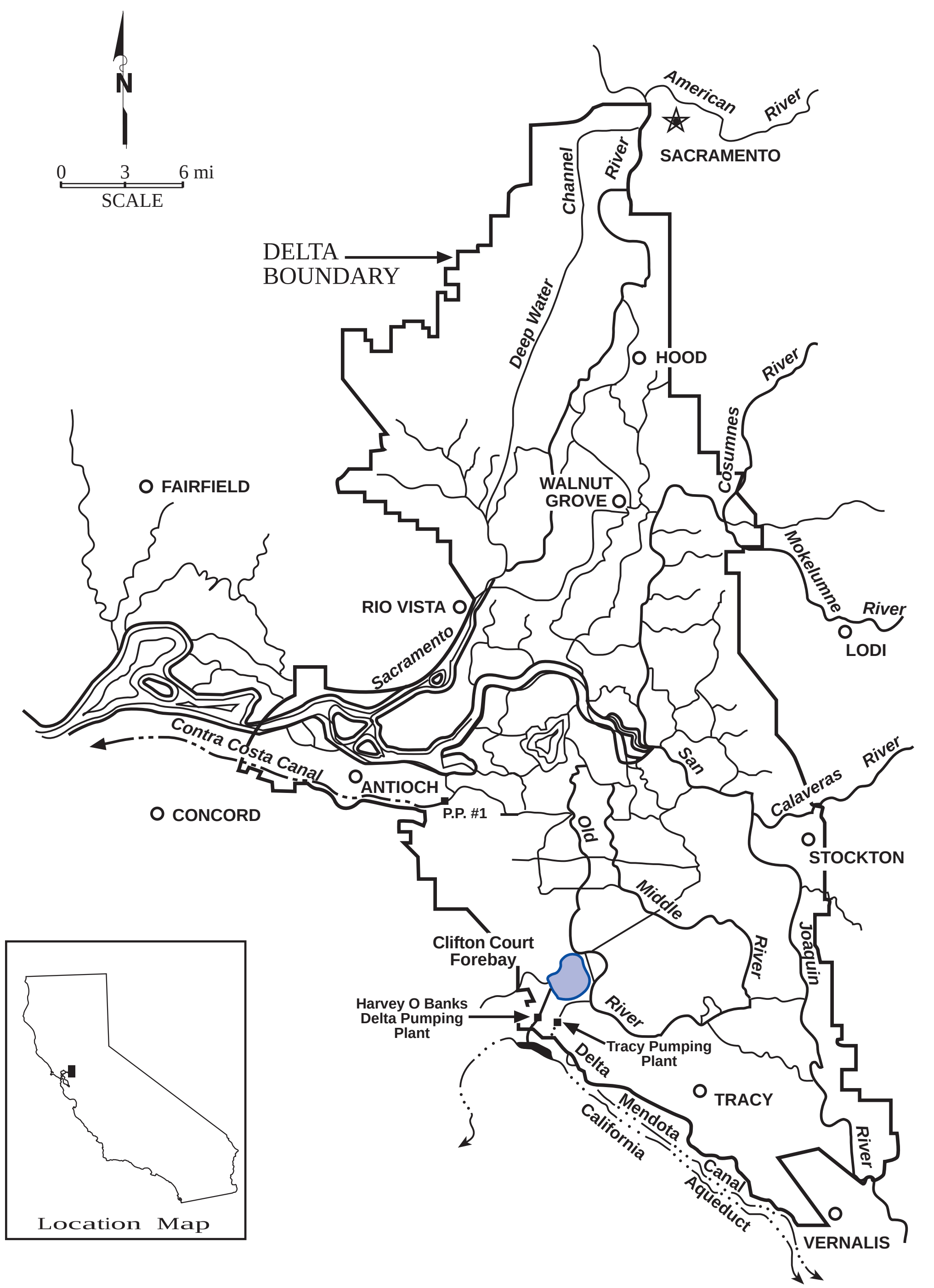
Behind the levees, surface elevations of many of the islands (particularly those in the central Delta) have subsided over the years due to oxidation and shrinkage of the peat soils and soil loss by wind erosion. As a result, some of the island surfaces now lie more than 20 feet below mean sea level and as much as 30 feet below high tide water levels in surrounding channels. All the major tracts and islands have been flooded at least once since their original reclamation, and a few have been allowed to remain flooded. Delta lands in the areas of deep peat soil, where subsidence has been greatest, are expensive both to protect from inundation and to reclaim from inundation once flooded.

The Delta area has a Mediterranean climate with warm, rainless summers and cool, moist winters. The annual rainfall varies from about 18 inches in the eastern and central parts to about 12 inches in the southern part. Ocean winds, which enter the Delta through the Carquinez Strait, are very strong at times in the western Delta.

2. Population

The population of the Sacramento-San Joaquin Delta is about 200,000 people, most of which is in upland areas on the eastern and western fringes. Although no major cities are entirely within the Delta, it does include a portion of Stockton, Sacramento, and West Sacramento. In addition, the cities of Antioch, Brentwood, Isleton, Pittsburg, and Tracy, plus about 14 unincorporated towns and villages, are located within the Delta. The Stockton area on the east and the Antioch-Pittsburg area on the west have undergone steady industrialization and urbanization. Most Delta islands are sparsely populated; however, some, including Byron Tract and Bethel Island, have large urban communities.

Figure III-12
Sacramento-San Joaquin Delta



3. Land Use and Economy

The Sacramento-San Joaquin Delta is an important agricultural area. Historically, the area was noted for its truck crops, such as asparagus, potatoes, and celery, but since the 1920's, there has been a shift toward lower valued field crops. Corn, grain, hay, and pasture currently account for more than 75 percent of the region's total production. The shift has been attributed mainly to market conditions, although changes in technology and growing conditions have also played a role. Delta farming produces an average gross income of about $375 million.

The western Delta includes some important industrial areas in eastern Contra Costa County. The extensive industrial complex adjacent to the San Joaquin River in the Antioch-Pittsburg area depends on the availability of large quantities of water for processing and cooling. The region also offers heavy industries the advantages of large land areas with waterfront access to a deep-water ship channel linking ocean and overland transportation. These industries include petroleum and coal products, paper and allied products, chemicals and allied products, primary metal industries, and food and related products.

Although much of the Delta is used for agriculture, the land also provides habitat for wildlife. Many agricultural fields are flooded in the winter, providing foraging and roosting sites for migratory waterfowl. In addition to these lands that are used seasonally, thousands of acres are managed specifically for wildlife. The DFG manages four such areas, including Lower Sherman Island and White Slough Wildlife Areas, Woodbridge Ecological Reserve, and Palm Tract Conservation Easement.

4. Water Supply

On the average, about 21 MAF of water reaches the Sacramento-San Joaquin Delta annually, but actual inflow varies widely from year to year and within the year. In 1977, a year of extraordinary drought, Delta inflow totaled only 5.9 MAF, while inflow for 1983, an exceptionally wet year, was about 70 MAF. On a seasonal basis, average natural flow to the Delta varies by a factor of more than 10 between the highest month in winter or spring and the lowest month in fall.
Surface water supplies are used to meet most of the water demand in the Delta region, especially for agricultural and industrial uses. Groundwater is used to meet some urban water demand and for domestic use in the upland areas around the periphery of the Delta.

a. Surface Water Hydrology. The Sacramento and San Joaquin rivers unite at the western end of the Sacramento-San Joaquin Delta at Suisun Bay. The Sacramento River contributes roughly 75 to 80 percent of the Delta inflow in most years, while the San Joaquin River contributes about 10 to 15 percent. The minor flows of the Mokelumne, Cosumnes, and Calaveras rivers, which enter into the eastern side of the Delta, contribute the remainder. The rivers flow through the Delta and into Suisun Bay. From Suisun Bay, water flows through the Carquinez Strait into San Pablo Bay, then south into San Francisco Bay, and then out to sea through the Golden Gate.

Hydraulics of the Estuary system are complex. The influence of tide is combined with freshwater outflow resulting in flow patterns that vary daily. Delta hydraulics are further complicated by a multitude of agricultural, industrial, and municipal diversions for use within the Delta itself, and by exports by the SWP and CVP.

Tidal influence is important throughout the Delta. The average tidal flow at Chipps Island, ebb or flood, is approximately 170,000 cfs. Historically, during summers when mountain runoff diminished, ocean water intruded into the Delta as far as Sacramento. During the winter and spring, fresh water from heavy rains pushed the salt water back, sometimes past the mouth of San Francisco Bay.

With the addition of Shasta, Folsom, and Oroville dams, saltwater intrusion into the Delta during summer months has been controlled by reservoir releases during what were traditionally the dry months. Typically, peaks in winter and spring flows have been dampened, and summer and fall flows have been increased. Average winter outflow is about 32,000 cfs while average summer outflow is about 6,000 cfs. In very wet years, such as 1969, 1982, 1983, and 1986, reservoirs are unable to control runoff so that during the winter and spring the upper bays become fresh; even at the Golden Gate, the upper several feet of water column sometimes consisted of fresh water.

In the Delta near Walnut Grove, the federal Delta Cross Channel diverts water, by gravity, from the Sacramento River into the North and South forks of the Mokelumne River. Sacramento River water moves down these channels through the central Delta and into the San Joaquin River. Flows in the Delta Cross Channel reverse as the tide changes and, at certain stages, there is considerable flow from the channel into the Sacramento River. Flows in the Delta Cross Channel can be controlled by two radial gates. The channel is closed for flood control purposes when Sacramento River flows exceed about 25,000 cfs. Other channels that convey water across the Delta include Georgiana Slough, and the San Joaquin, Old, and Middle rivers.

b. Surface Water Quality. The existing water quality problems of the Sacramento-San Joaquin Delta system may be categorized by toxic materials, eutrophication and associated dissolved oxygen fluctuations, suspended sediments and turbidity, salinity, and bacteria.

Many Delta waterways have impaired water quality due to toxic chemicals. High concentrations of some metals from point and nonpoint sources appear to be ubiquitous in the Delta. Tissues from fish taken throughout the Delta exceed the National Academy of Sciences/Food and Drug Administration guidelines for mercury. There is currently a health advisory in effect for mercury in striped bass. High levels of other metals (i.e., copper, cadmium, and lead) in Delta waters are also of concern. Also, in localized areas of the Delta (e.g., near Antioch and in Mormon Slough), fish tissues contain elevated levels of dioxin as a result of industrial discharges.
Pesticides are found throughout the waters and bottom sediments of the Delta. High levels of chlordane, toxaphene, and DDT from agricultural discharges impair aquatic life beneficial uses throughout the Delta, while diazinon can be found in elevated concentrations at various locations. The more persistent chlorinated hydrocarbon pesticides are consistently found throughout the system at higher levels than the less persistent organophosphate compounds. The sediments having

the highest pesticide content are found in the western Delta. Pesticides have concentrated in aquatic life in the Delta. The long-term effects of pesticide concentrations found in aquatic life of the Delta are not known. The effects of intermittent exposure of toxic pesticide levels in water and of long-term exposure to these compounds and combinations of them are likewise unknown.

Much of the water in the Delta system is turbid as a result of an abundance of suspended silts, clays, and organic matter. Most of these sediments enter the tidal system with the flow of the major tributary rivers. Some enriched areas are turbid as a result of planktonic algal populations, but inorganic turbidity tends to suppress nuisance algal populations in much of the Delta. Continuous dredging operations to maintain deep channels for shipping has contributed to turbidity of Delta waters and is a factor in the temporary destruction of bottom organisms through displacement and suffocation.

The most serious enrichment problems in the Delta are found along the lower San Joaquin River and in certain localized areas receiving waste discharges, but having little or no net freshwater flow. These problems result in low dissolved oxygen levels which occur mainly in the late summer and coincide with low river flows and high temperatures. Dissolved oxygen problems are further aggravated by channel deepening for navigational purposes. The resulting depressed dissolved oxygen levels have not been sufficient to support fish life and, therefore, prevent fish from moving through the area. In the autumn these conditions, together with reversal of natural flow patterns by export pumping, have created environmental conditions unsuitable for the passage of anadromous fish (salmon) from the Delta to spawning areas in the San Joaquin Valley.

Warm, shallow, dead-end sloughs of the eastern Delta support objectionable populations of planktonic blue-green algae during summer months. Floating and semi-attached aquatic plants, such as water primrose and water hyacinths, frequently clog waterways in the lower San Joaquin River system during the summer. Extensive growths of these plants have also been observed in the waterways of the Delta. These plants interfere with the passage of small boat traffic and contribute to the total organic load in the Bay/Delta system as they break loose and move downstream in the fall and winter months.

Local diversions in shallow, low capacity channels may at times exceed flows through the channel. When this happens, water stops flowing out of the channel, or begins to flow into the channel from both ends. At the same time, drainage return flows continue to be discharged to the channels. These discharges do not move downstream and out of the area, but instead become trapped in "null zones" of zero net flow. The lack of circulation prevents better quality water otherwise available from the main channels from freshening the increasingly saline water in the shallow channel, even in wet years. Null zones exist predominantly in three areas of the Delta: in Old River between Sugar Cut and the CVP intake; in Middle River between Victoria canal and Old River; and in the San Joaquin River between the head of Old River and the City of Stockton.

Reduced tidal influence contributes to the surface water quality problems of the Delta. Previous reclamation of tidal wetlands and construction of levees in areas such as the eastern Delta have inhibited tidal exchange. Historically, larger volumes of water were exchanged twice daily with adjacent tidal wetlands and the resulting flows helped keep channels open and reduced the risk of water quality problems.

Salinity control is necessary because the Delta is contiguous with the ocean, and its channels are at or below sea level. Unless repelled by continuous seaward flow of fresh water, seawater will advance up the Estuary into the Delta and degrade water quality. During winter and early spring, flows through the Delta are usually above the minimum required to control salinity. At least for a few months in the summer and fall of most years, however, salinity must be carefully monitored and controlled. The monitoring and control is provided by the CVP and SWP, and regulated by the SWRCB under its water rights authority.

At present, salinity problems occur mainly during years of below normal runoff. In the eastern Delta, these problems are largely associated with the high concentrations of salts carried by the San Joaquin River into the Delta. Operation of the State and federal export pumping plants near Tracy draws high quality Sacramento River water across the Delta and restricts the low quality area to the southeast corner. Localized problems resulting from irrigation returns occur elsewhere, such as in dead-end sloughs. Salinity problems in the western Delta result primarily from the incursion of saline water from the San Francisco Bay system. The extent of incursion is determined by the freshwater flow from the Delta to the Bay. Salinity in the western Delta can impact municipal and industrial uses.

Bacteriological quality of Delta waters, as measured by the presence of coliform bacteria, varies depending upon proximity of waste discharges and significant land runoff. The highest concentration of coliform organisms is generally found in the western Delta. Local exceptions to this can be found in the vicinity of major municipal waste discharges.
Another human health concern is that of disinfecting by-products. Delta water contains precursors of trihalomethanes (THMs), which are suspected carcinogens produced when chlorine used for disinfecting reacts with natural substances during the water treatment process. Dissolved organic compounds that originate from decayed vegetation act as precursors by providing a source of carbon in THM formation reactions. During periods of low Delta outflow, tidal mixing of bromides from the ocean extend further into the Delta, thereby increasing the bromide concentrations in the vicinity of municipal drinking water intakes. When bromides are present in water along with organic THM precursors, THMs are formed during the treatment process that contain bromine as well as chlorine. When ozonation is used for disinfection of water with high concentrations of bromide, it results in the formation of bromate, which is also a suspected human carcinogen. Drinking water supplies taken from the Delta are treated to meet current THM standards. However, more restrictive standards are being considered which, if adopted, will increase the cost and difficulty of treating present Delta water sources.

c. Groundwater Hydrology. The groundwater hydrology of the Sacramento-San Joaquin Delta is contiguous with the lower portions of the Sacramento and the San Joaquin River Basins in the Central Valley regional aquifer system. Large amounts of water are stored in thick sedimentary deposits. Groundwater is replenished through deep percolation of streamflow, precipitation, and applied irrigation water. Recharge by subsurface inflow is negligible compared to other sources.

Groundwater is used to meet urban water demand and for domestic use in the upland areas around the periphery of the Delta. Groundwater use is not significant in the Delta lowlands where agricultural water demand is met with abundant surface water supplies.

d. Groundwater Quality. Groundwater quality in the Sacramento-San Joaquin Delta is generally very good throughout the area and is suitable for most uses, although at shallow depths within the Delta the water is often saline.

5. Water Use

The Sacramento-San Joaquin Delta is the hub of the major State and federal water development facilities, and numerous local water supply projects. Water projects divert water from Delta channels to meet the needs of about two-thirds of the State's population and to irrigate 4.5 million acres. During normal water years, about 10 percent of the water reaching the Delta would be withdrawn for local use, 30 percent would be withdrawn for export by the CVP and SWP, 20 percent would be needed for salinity control, and the remaining 40 percent would become Delta outflow in excess of minimum requirements. The excess outflow would occur almost entirely during the season of high inflow.

Delta agricultural water users divert directly from the channels, using more than 1,800 unscreened pumps and siphons, which vary from 4 to 30 inches in diameter, and with flow rates of 40 to about 200 cfs. These local diversions vary between 2,500 and 5,000 cfs during April through August, with maximum rates in July.

6. Vegetation

Sacramento-San Joaquin Delta vegetation community types include valley and foothill riparian, valley grassland, and freshwater emergent wetland. The complex interface between land and water in the Estuary provides rich and varied habitat for wildlife, especially birds. Dense stands of tules are found throughout the Delta. Many of the levees are covered in blackberry vines. Floating and semi-attached aquatic plants, such as water primrose and water hyacinths, frequently clog waterways of the Delta during the summer.

Sensitive riparian habitat types in the Delta that can be grouped into the valley and foothill riparian community type include: great valley-valley oak riparian forest, great valley cottonwood riparian forest, great valley mixed riparian forest, great valley willow scrub, buttonbush scrub, elderberry savanna, and central coast riparian scrub. Sensitive valley grassland communities include vernal pools, valley needlegrass grassland, serpentine bunchgrass, wildflower fields, freshwater seeps, alkali playas, coastal terrace prairie, and pine bluegrass grassland. There are three sensitive freshwater emergent wetland communities in the Delta: cismontane alkali marsh, coastal and valley freshwater marsh, and vernal marsh. Twelve rare or endangered plant species, most of which are associated with freshwater marshes, can also be found in the Delta. Table III-17 lists the sensitive plant species found in the Sacramento-San Joaquin Delta.

7. Fish

The Sacramento-San Joaquin Delta supports about 90 species of fish. The Delta, which is basically a freshwater environment, serves as a migratory route and nursery area for chinook salmon, striped bass, white and green sturgeon, American shad, and steelhead trout. These anadromous fishes spend most of their adult lives either in the lower bays of the Estuary or in the ocean. The Delta is a major nursery area for most of these species. Other fishes in the Estuary include delta smelt, Sacramento splittail, catfish, largemouth bass, black bass, crappie, and bluegill. The Sacramento perch is believed to have been extirpated from the Delta; however, it still exists in scattered ponds throughout the Central Valley. Table III-18 lists the sensitive fish species found in the Sacramento-San Joaquin Delta.

The Delta provides habitat for a wide variety of freshwater, estuarine, and marine fish species. Channels in the Delta range from dead-end sloughs to deep, open water areas and include a scattering of flooded islands that provide submerged vegetative shelter. The banks of the channels

Table III-17
Sensitive Plant Species in the Sacramento-San Joaquin Delta

		Status		
Scientific Name	Common Name	State	CNPS	Federal
Acanthomintha duttonii	San Mateo thornmint	SE	1B	FE
Amsinckia grandiflora	Large-flowered fiddleneck	SE	1B	FE
Cordylanthus palmatus	Palmate-bracted bird's-beak	SE	1B	FE
Eryngium racemosum	Delta button-celery	SE	1B	FSC
Erysimum capitatum spp. angustatum	Contra Costa wallflower	SE	1B	FE
Gratiola heterosepala	Boggs Lake hedge-hyssop	SE	1B	
Lasthenia conjugens	Contra Costa goldfields		1B	FPE
Lilaeopsis masonii	Manson's lilaeopsis	SR	1B	FSC
Neostapfia colusana	Colusa grass	SE	1B	FT
Oenothera deltoides spp. howellii	Antioch Dunes evening-primrose	SE	1B	FE
Tuctoria mucronata	Crampton's tuctoria	SE	1B	FE

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.

CNPS: (California Native Plant Society) 1A=presumed extinct in California; 1B=rare,threatened, or endangered in California and elsewhere; 2=rare,threatened,or endangered in California but more common elsewhere; 3=need more information; 4=distribution limited (a watchlist).

FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

Table III-18
Sensitive Fish Species in the Sacramento-San Joaquin Delta

Scientific Name	Common Name	Status State	Status Federal
Acipenser medirostris	Green Sturgeon	CSC	FSC
Hypomesus transpacificus	Delta smelt	ST	FT
Mylopharodon conocephalus	Hardhead	CSC	
Oncorhynchus tshawytscha	Fall-run chinook salmon, Central Valley, CA ESU		C
Oncorhynchus tshawytscha	Late fall-run chinook salmon, Central Valley, CA ESU	CSC	C
Oncorhynchus tshawytscha	Spring-run chinook salmon	ST	FT
Oncorhynchus tshawytscha	Winter-run chinook salmon	SE	FE
Oncorhynchus mykiss	Steelhead, Central Valley, CA ESU		FT
Pogonichthys marcrolepidotus	Sacramento splittail	CSC	FT
Spirinichus thaleichthys	Longfin smelt	CSC	FSC

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
FEDERAL: FE=endangered; FT=threatened; C=candidate for listing; FSC=species of concern.
Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

are varied and include riprap, tules, emergent marshes, and native riparian habitats. Water temperatures generally reflect ambient air temperatures; however, riverine shading may moderate summer temperatures in localized areas.

Food supplies for Delta fish communities consist of phytoplankton, zooplankton, benthic invertebrates, insects, and forage fish. The entrapment zone, where freshwater outflow meets and mixes with the more saline water of the bay, concentrates sediments, nutrients, phytoplankton, some fish larvae, and other fish food organisms. Biological standing crop (biomass) of phytoplankton and zooplankton in the estuary has generally been highest in this zone. General productivity in the Delta is in constant flux and an evaluation of the interrelationships of the food web is now underway by the Interagency Ecological Program. There are indications that overall productivity at the lower food chain levels has decreased during the past 15 or so years.

Flows which are provided or controlled by the CVP and SWP affect fish in numerous ways. Flows toward the project pumps draw both fish and fish food organisms into the export facilities. Most larger fish are screened out; however, many do not survive screening and subsequent handling. Most of the fish less than about an inch long and the fish food organisms pass through the screens and are removed from the Delta (additional discussion of entrainment related impacts is provided in Chapter VI). In addition, the draw of the pumps may cause water in some channels to flow too fast for optimal fish food production, and reverse flows in some channels may disorient migrating fish. Delta flows may act as cues for anadromous fish outmigrating to the ocean.

Factors other than CVP and SWP operations that affect fish include: water diversions within the Delta; upstream spawning conditions and diversions; municipal, industrial, and agricultural water pollution; habitat reduction by landfills; legal and illegal harvest; competition from introduced species; natural predator/prey interactions; and drought. Cumulative effects of these and other factors have contributed to declining populations of many Delta fish.

8. Wildlife

The complex interface between land and water in the Delta provides rich and varied habitat for wildlife, especially birds. Wildlife habitats include agricultural land, riparian forest, riparian scrub-shrub, emergent freshwater marsh, heavily shaded riverine aquatic, and grassland/rangeland.

The Delta is particularly important to waterfowl migrating via the Pacific Flyway. The principal attraction for waterfowl is winter-flooded fields, mainly cereal crops, which provide food and extensive seasonal wetlands. The Delta and other Central Valley wetlands provide winter habitat for 60 percent of waterfowl on the Pacific Flyway and 91 percent of all waterfowl that winter in California. More than a million waterfowl are frequently in the Delta at one time.

Small mammals find suitable habitat in the Delta and upland areas. Vegetated levees, remnants of riparian forest, and undeveloped islands provide some of the best mammalian habitat in the region. Species include muskrat, mink, river otter, beaver, raccoon, gray fox, and skunks. Other wildlife found in the area include many species of songbirds, as well as raptors, reptiles, and amphibians.

Numerous listed or candidate rare, threatened, and endangered species inhabit the Delta, but none is confined exclusively to that area. Currently, 19 wildlife species in the Delta are listed by either the State or the Federal government as threatened or endangered. Other wildlife species occurring in the Delta have been proposed for listing or are candidates for proposal. Table III-19 lists the sensitive wildlife species found in the Sacramento-San Joaquin Delta.

9. Recreation

Although the Delta environment has been extensively altered over the past 125 years by reclamation and development, natural and aesthetic values remain that make it a valuable and unique recreational asset. Waterfowl and wildlife are still abundant, sport fishing is still popular, and vegetation lining the channels and islands are still attractive. As a result, the miles of channels and sloughs that interlace the area attract a diverse and growing number of people seeking recreation. DWR estimated annual use at 12 million visitor days in 1993.

With its unique and numerous recreational opportunities, the Delta will continue to support large numbers of recreationists. Motor boating and fishing are the leading activities, with estimates of 17 and 15 percent of total recreation visits. Overnight camping, hunting, picnicking, swimming, and water-skiing are enjoyed by many people. The extensive riparian vegetation of the Delta area is

Table III-19
Sensitive Wildlife Species in the Sacramento-San Joaquin Delta

Scientific Name	Common Name	Status State	Status Federal
Agelaius tricolor	Tricolored blackbird	CSC	FSC
Charadrius alexandrinus nivosus	Western snowy plover	CSC	FT
Grus canadensis tabida	Greater sandhill crane	ST	
Haliaeetus leucocephalus	Bald Eagle	SE	FT
Laterallus jamaicensis coturniculus	California black rail	ST	FSC
Riparia riparia	Bank swallow	ST	
Antrozous pallidus	Pallid bat	FSC	
Eumops perotis californicus	California mastiff bat	CSC	FSC
Plecotus townsedii townsedii	Townsend's western big-eared bat	CSC	FSC
Reithrodontomys raviventris	Salt marsh harvest mouse	SE	FE
Sylvilagus bachmani riparius	Riparian brush rabbit	SE	C
Vulpes macrotis mutica	San Joaquin kit fox	ST	FE
Ambystoma californiense	California tiger salamander	CSC	C
Rana aurora draytonii	California red-legged frog	CSC	FT
Clemmy's marmorata	Western pond turtle	CSC	
Thamnophis gigas	Giant garter snake	ST	FT
Apodemia mormo langei	Lange's metalmark butterfly		FE
Branchinecta conservatio	Conservancy fairy shrimp		FE
Branchinecta longiantenna	Longhorn fairy shrimp		FE
Branchinecta lynchi	Vernal pool fairy shrimp		FT
Desmocerus californicus dimorphus	Valley elderberry longhorn beetle		FT
Elaphrus viridis	Delta green ground beetle		FT
Lipidurus packardi	Vernal pool tadpole shrimp		FE

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

conducive to sightseeing, bird watching, and relaxing. Photography, bicycling, and sailing also occur in the Delta, although less frequently. During the 1976-77 and 1987-92 droughts, when most reservoirs throughout the State were extremely low, the Delta provided the same water-based recreational opportunities as in other years. There are about 20 public and more than 100 commercial recreational facilities in the Delta. These facilities provide rentals, services, camping guest docks, fuel, supplies and food.

Sport fishing in the Delta occurs year-round and takes place from private vessels, charter boats, and from shore. Species popular for sport fishing include striped bass, white sturgeon, salmon, American shad, catfish and largemouth bass. There are numerous private waterfowl and pheasant hunting clubs in the Delta region. Approximately 39,100 acres are flooded annually.

F. SUISUN MARSH

Suisun Marsh, shown in Figure III-13, is one of the few major marshes remaining in California and the largest remaining brackish wetland in Western North America. Located at the northern edge of Suisun Bay, just west of the confluence of the Sacramento and San Joaquin rivers and south of the City of Fairfield, the marsh consists of a unique diversity of habitats, including tidal wetlands, sloughs, managed diked wetlands, unmanaged seasonal wetlands, and upland grasslands. Numerous studies have established that tidal marshlands can have significant geomorphic and ecological values, including flood control, shoreline stabilization, sediment entrapment, water quality improvement, and food chain support for aquatic, semi-aquatic, and terrestrial plants and animals.

Under the 1984 Plan of Protection for the Suisun Marsh and the 1985 Suisun Marsh Preservation Agreement, the staged construction of extensive marsh water control facilities was planned in order to mitigate the effects of upstream water projects on the managed wetlands in Suisun Marsh. To date, the Initial Facilities (Roaring River Distribution System, Morrow Island Distribution System, and Goodyear Slough Outfall) and the Montezuma Slough Salinity Control Gates have been constructed. These facilities help to ensure that a dependable supply of suitable salinity water is available to preserve managed wetland habitat, including food plants for waterfowl.

1. Land Use

The portion of Suisun Marsh within the Suisun Resource Conservation District boundaries includes 52,000 acres of diked, managed wetlands; 6,300 acres of relict tidal marsh; 29,300 acres of bays and sloughs; and 27,000 acres of grasslands including vernal pools and other natural seasonal wetlands. These acreage figures do not include the diked and tidal wetlands adjacent to the Contra Costa shoreline, which are part of the Suisun Ecosystem and under the influence of regulatory standards reviewed in the draft EIR. The diked managed wetlands within Suisun include 153 privately owned managed wetlands. The Department of Fish and Game manages 15,000 acres of land, which includes diked wetlands, tidal marsh, and uplands. Concord Naval Weapons Station owns channel islands (Seal Island, Roe Island, Ryer Island, Snag Island, and Freeman Island) which are undiked tidal marsh set aside as wildlife sanctuary which support a variety of listed species.

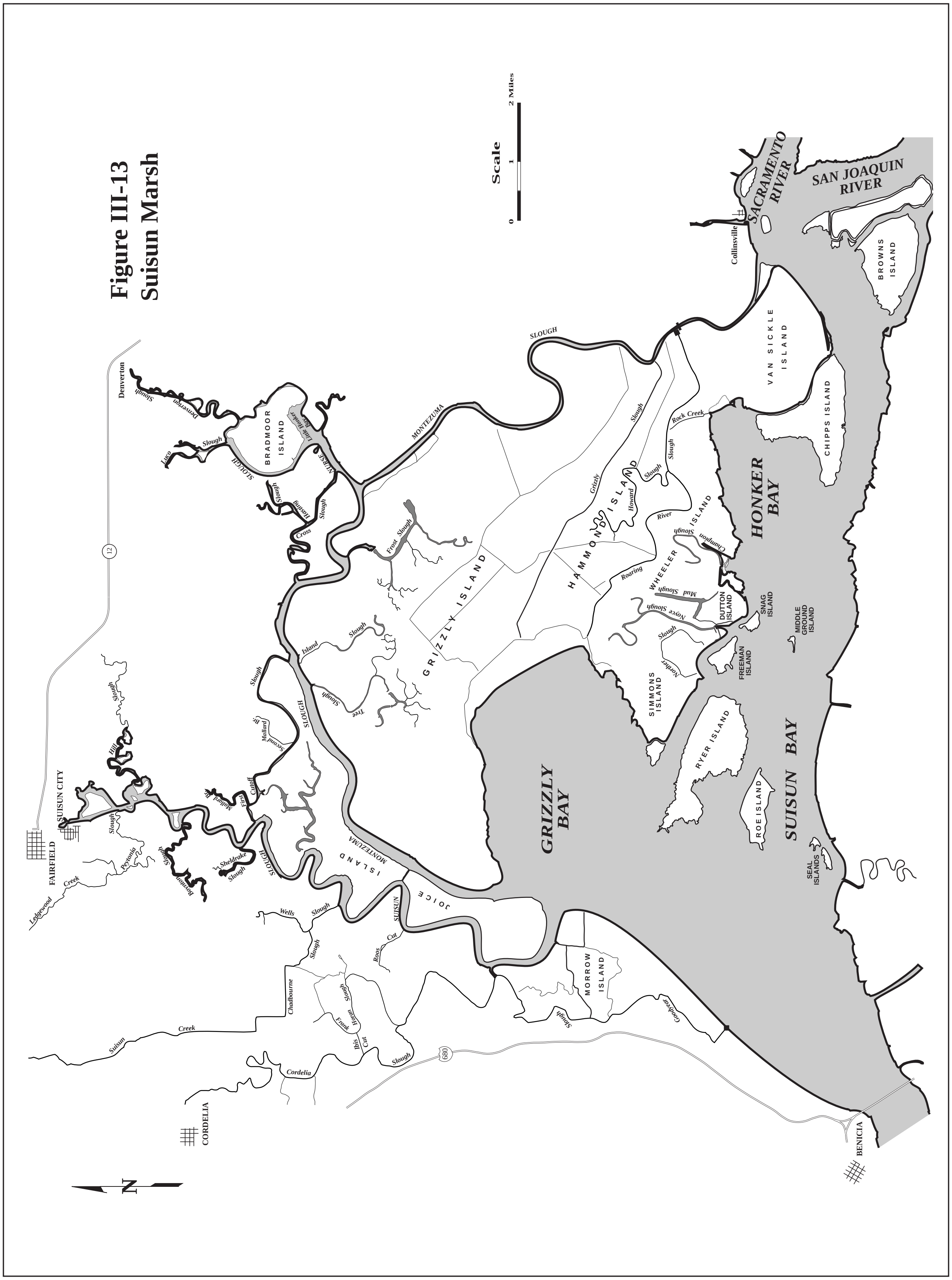


Figure III-13
Suisun Marsh

2. Vegetation

Elevation and salinity are the principal factors controlling the distribution of tidal marsh plants in San Francisco Bay and Suisun Marsh. The mix of plants influences the quality and quantity of habitat available for many species of wildlife. The structure of the plant communities in tidal marshland is strongly correlated to salinity regime. Within the diked wetlands, hydroperiod and management strategies are manipulated to maximize the production of alkali bulrush, fat hen, and brass buttons, plants which have traditionally been considered important for wintering waterfowl. Suisun Marsh supports two endangered plant species (soft haired bird's beak and Suisun thistle) which are both endemic to Suisun Marsh, the rare Mason's lilaeopsis, and several species of concern considered to be in decline due to habitat fragmentation and fill (Delta tule pea, Suisun aster, and Contra Costa goldfields). A more complete listing of sensitive species found in the Suisun Marsh is included in Table VII-11, later in this document.

3. Wildlife and Fish

Suisun Marsh supports 45 species of mammals, 230 species of birds, 51 species of fish, and 15 species of reptiles and amphibians. The marsh is a major wintering ground for waterfowl of the Pacific Flyway. Ducks, geese, swans, and other migrant waterfowl use the marsh as a feeding and resting area. As many as 25 percent of California's wintering waterfowl inhabit the marsh in dry winters. Waterfowl are attracted to the marsh by the water and the abundance of food plants. The growth of such plants depends on soil salinity, which is affected by the salinity of applied water and by land management practices. Freshwater flows from the Delta and tributary creeks into Suisun Bay and marsh channels affect the marsh salinities and waterfowl food production.

Striped bass, for which the marsh is an important nursery area, are the most common fish found in the marsh channels. Other anadromous species sometimes found in the marsh include chinook salmon, sturgeon, American shad, and steelhead trout. Delta smelt, Sacramento splittail, and longfin smelt are important native fish found in the marsh. Catfish are a common resident species in Suisun Marsh and provide a popular sport fishery.

Two endangered species (the salt marsh harvest mouse and the California clapper rail), one threatened species (the California black rail), and one candidate species for federal listing (the Suisun song sparrow) are found in the marsh.

G. SAN FRANCISCO BAY REGION

1. Geography and Climate

The San Francisco Bay Region, shown in Figure III-14, includes portions of nine counties surrounding the San Francisco Bay system and extends from Tomales Bay in the north to Pescadero Creek in the south and inland to the confluence of the Sacramento and San Joaquin rivers. The total land area of the region encompasses about 4,400 square miles, or 3 percent of the

State's total area. The mountains of the Coast Range rise to over 3,000 feet above sea level to the north and south of San Francisco Bay. The North Bay area includes the Napa and Sonoma valleys and the South Bay area includes the Santa Clara Valley. The Golden Gate connects San Francisco Bay to the Pacific Ocean and separates the San Francisco and Marin peninsulas.

San Francisco Bay, which includes Suisun, San Pablo, Central, and South bays, extends about 85 miles from the east end of Chipps Island (in Suisun Bay near the City of Antioch) westward and southward to the mouth of Coyote Creek (tributary to South Bay near the City of San Jose). The surface area of San Francisco Bay is about 400 square miles at mean tide. This is about a 40 percent reduction, due to fill, from its original size. Most of the bay's shoreline has a flat slope, which causes the intertidal zone to be relatively large. San Francisco Bay is surrounded by about 130 square miles of tidal flats and marshes.

The climate is generally cool and often foggy along the coast, with warmer Mediterranean-like weather in the inland valleys. The average high temperature in the inland valleys is nearly 10 degrees higher than at San Francisco. The gap in the hills at Carquinez Strait allows cool air to flow at times from the Pacific Ocean into the Central Valley. Most of the interior North Bay and the northern portions of the South Bay, by contrast, experience very little marine air movement. Average precipitation ranges from 14 inches at Livermore in the South Bay to almost 48 inches at Kentfield in Marin County in the North Bay.

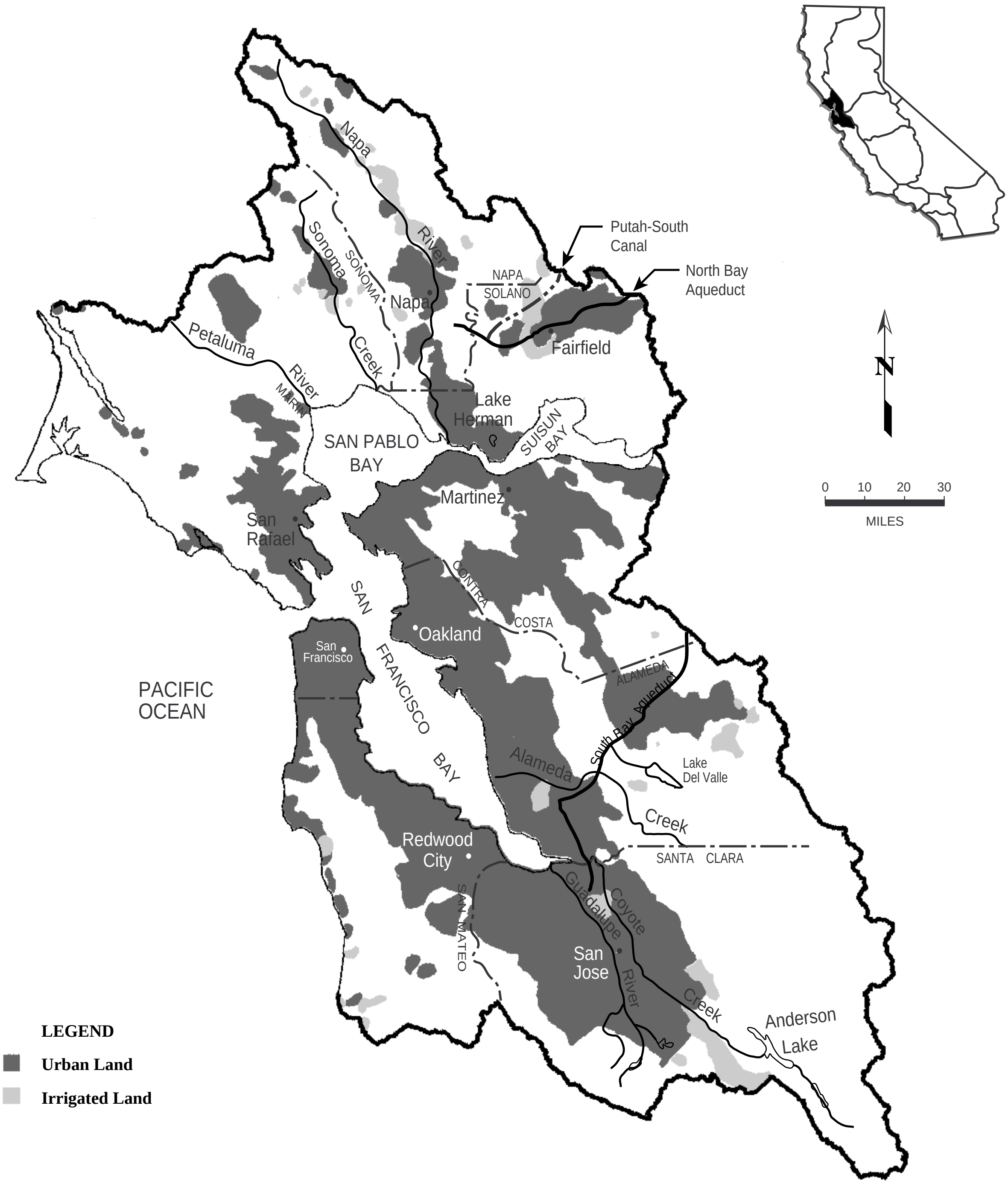
2. Population

The region is highly urbanized and includes the San Francisco, Oakland, and San Jose metropolitan areas. There are large undeveloped areas in the north, west, and southeast portions of the region. In 1990 the population for this region was nearly 5.5 million, which was about 18 percent of the State's total population and an increase of nearly 700,000 from the 1980 level. Most of the region's population lives in the South Bay area and much of the growth took place in the eastern part of that area. The population of the San Francisco Bay Region is expected to increase to over 6.9 million by 2020.

3. Land Use and Economy

The land use in the San Francisco Bay Region is very diverse. Much of the economy is based on commerce and industry. The City of San Francisco is a center of international business and tourism, the ports on the bay support shipping and trade, and the "Silicon Valley" is known for its technological development and production. The region also is home to the Napa Valley and Sonoma Valley wine industry.

Figure III-14
San Francisco Bay Region



Source: DWR, Bulletin 160-93 (1994)

Urban land accounts for 23 percent (655,600 acres) of the land area in the region. This proportion is expected to increase to 37 percent by 2020. Irrigated agricultural land in 1990 was 61,400 acres, which includes 36,000 acres of vineyards. Other irrigated crops include truck, orchard, alfalfa, and pasture. High-value crops include flowers and specialty vegetables, such as artichokes. Public lands make up a small portion of the total region.

4. Water Supply

Water supply sources for the San Francisco Bay Region include local surface water, imported surface water (both locally developed and purchased from other local agencies), groundwater, CVP water, other federal project water (Solano Project), SWP water, and a small amount of recycled waste water. About two-thirds of the urban supplies are imported to the region. More than 60 percent of the total water supply comes from the Delta. The conveyance systems that bring the majority of the water to the area are: the Hetch Hetchy, South Bay, North Bay, Mokelumne, Petaluma, and Santa Rosa-Sonoma aqueducts; Contra Costa and Putah South canals; Cache Slough Conduit; and the San Felipe Project.

Local Surface Supplies - Local surface supplies provide 365,000 acre-feet to the region in average years. Marin Municipal Water District (MMWD) serves the most populated southeastern portion of Marin County with local supplies stored in its reservoirs within Marin County. North Marin Water District (NMWD) supplements its imported supply from Sonoma County Water Agency (SCWA) with just over 1,000 acre-feet from Stafford Lake. The cities of Napa, Vallejo, and St. Helena receive surface water from reservoirs in Napa and Sonoma counties. Vineyards along the Napa River annually divert approximately 6,000 acre-feet from the river for irrigation and frost protection. The City of San Francisco, East Bay Municipal Water District (EBMUD), and Santa Clara Valley Water District (SCVWD) have developed most of the surface supplies in the South Bay area. The major reservoirs in the region are listed in Table III-20.

Imports by Local Agencies - In the North Bay, water is imported from the Russian and Eel rivers (North Coast Region) by SCWA and from the Delta by the City of Vallejo through the SWP. SCWA delivers water from the Russian River Project (which includes Lake Mendocino and Lake Sonoma, and the Potter Valley Project) to eight principal contractors, including four in the San Francisco Bay Region (Petaluma, Sonoma, Valley of the Moon, and North Marin water districts). NMWD supplements its local supply with water from SCWA.

San Francisco Water District (SFWD) imports Tuolumne River water via the 150-mile long Hetch Hetchy System. In addition to supplying water to the City and County of San Francisco, SFWD sells water wholesale to 30 water districts, cities, and local agencies in Alameda, Santa Clara, and San Mateo counties. The three pipelines in the Hetch Hetchy Aqueduct are capable of delivering 336,000 acre-feet annually to the Bay Area.

Table III-20
Major Reservoirs in the San Francisco Bay Region

Reservoir	River	Capacity (TAF)	Owner
Los Vaqueros	Kellogg Creek	100.0	CCWD
Lake Hennessey	Conn Creek	31.0	City of Napa
Nicasio	Nicasio Creek	22.4	Marin MWD
Kent Lake	Lagunitas Creek	32.9	Marin MWD
Alpine	Lagunitas Creek	8.9	Marin MWD
Soulajule	Walker Creek	10.6	Marin MWD
San Pablo	San Pablo Creek	38.6	East Bay MUD
New Upper San Leandro	San Leandro Creek	41.4	East Bay MUD
Chabot	San Leandro Creek	10.4	East Bay MUD
Briones	Bear Creek	60.5	East Bay MUD
Del Valle	Arroyo del Valle	77.1	DWR
San Antonio Reservoir	San Antonio Creek	50.5	City of San Francisco
Coyote	Coyote Creek	22.9	Santa Clara Valley WD
Leroy Anderson	Coyote Creek	89.7	Santa Clara Valley WD
Lexington	Los Gatos Creek	19.8	Santa Clara Valley WD
Lake Elsman	Los Gatos Creek	6.2	San Jose Water Works
Calaveras	Calaveras Creek	96.9	City of San Francisco
San Andreas	San Andreas Creek	19.0	City of San Francisco
Crystal Springs	San Mateo Creek	58.4	City of San Francisco

Source: DWR 1993b

EBMUD imports water from the Mokelumne River through its aqueducts and delivers this water to much of Alameda and Contra Costa counties. The district supplies water to approximately 1.2 million people in 20 cities and 15 unincorporated communities. EBMUD has water rights and facilities to divert up to 364,000 acre-feet annually from the Mokelumne River, depending on streamflow and water use by other water rights holders.

Contra Costa Water District (CCWD) delivers water throughout eastern Contra Costa County, including a portion of the district in the San Joaquin River Region. The district has a right to divert almost 27,000 acre-feet from Mallard Slough on Suisun Bay. With SWRCB Decision 1629, CCWD received a new water right associated with the Los Vaqueros Project, which allows it to divert up to 95,850 acre-feet of surplus water from the Delta to Los Vaqueros Reservoir. The 100,000 acre-foot reservoir, which was authorized in 1988 and recently constructed, will improve supply reliability and water quality by allowing the district to pump and store water from the Delta during high flows. The reservoir provides an emergency water supply to the District and provides blending water to reduce chlorides during periods of higher salinity in the Delta.

Groundwater - The annual supply from groundwater in the region is about 100,000 acre-feet in average years. This figure does not include the use of groundwater which is artificially recharged from surface sources into the groundwater basins. The larger alluvial basins in the North Bay area include Suisun-Fairfield, Napa-Sonoma, Petaluma, and Novato valleys. The estimated storage in these basins is 1.7 million acre-feet. The major groundwater basins of the South Bay area include the Santa Clara and Livermore valleys and the Pittsburg Plain. The total storage in the South Bay basins is estimated to be 6.5 million acre-feet.

Artificial recharge programs are in place in several South Bay localities. Programs operated by Alameda County Flood Control & Water Conservation District (Zone 7), Alameda County Water District, and SCVWD have resulted in a general rise to near-historic groundwater levels in many of the basins. These efforts have corrected overdraft problems such as salt-water intrusion in the Pittsburg Plain and land subsidence in the northern Santa Clara Valley.

Central Valley Project - CVP water is delivered through the Contra Costa Canal to the CCWD and through the San Felipe Project to SCVWD. CVP water was first delivered by CCWD in 1940. The current contract with USBR is for 195,000 acre-feet per year. Most of CCWD's demands are met through direct diversions from the Delta through the Contra Costa Canal. SCVWD's maximum entitlement from the CVP's San Felipe Division, which became operational in 1987, is 152,500 acre-feet per year. Average year deliveries to the region are about 93,200 acre-feet. Normally, about half of this water is used for recharge and the rest is used for direct supply.

Other Federal Projects - Solano County Water Agency contracts for water from Lake Berryessa via the Solano Project and delivers it to farmers and cities within the county. The project was built by the USBR and began operation in 1959. The project develops a dependable supply of over 200,000 acre-feet per year and most of the entitlement goes to agricultural users in the Sacramento River Basin. The 1990 level average year supply from the Solano Project to the North Bay area is 54,000 acre-feet.

State Water Project - The SWP delivers water through the North Bay Aqueduct to the Solano County Water Agency and Napa County Flood Control and Water Conservation District. The Aqueduct extends over 27 miles from Barker Slough to the Napa Turnout Reservoir in southern Napa County. Maximum SWP entitlements are for 67,000 acre-feet per year. The aqueduct also conveys water for the City of Vallejo, which purchased capacity in the NBA.

The South Bay Aqueduct conveys SWP water to SCVWD, Zone 7, and ACWD. The aqueduct is over 42 miles long beginning at the SWP's South Bay pumping plant on Bethany Reservoir and ending at the Santa Clara Terminal Facilities. SWP water is used in the South Bay area for municipal and industrial supply, agricultural deliveries, and groundwater recharge.

a. **Surface Water Hydrology**. The principal source of fresh water in San Francisco Bay is outflow from the Delta. Delta outflows vary greatly according to month and hydrologic year type. Historical Delta outflows have dropped to zero during critically dry periods such as 1928 and 1934. Present summer outflows are maintained by upstream reservoir releases. Although annual Delta outflow has averaged 27.8 MAF from 1980 to 1991, it has varied from less than 2.5 MAF in 1977 to more than 64 MAF in 1983.

Other significant sources of freshwater inflow to San Francisco Bay are the Napa, Petaluma, and Guadalupe rivers, and Alameda, Coyote, Walnut, and Sonoma creeks. These tributaries make up a total average inflow of about 350 TAF. Stream flow is highly seasonal, with more than 90 percent of the annual runoff occurring during November through April. Many streams often have very little flow during mid- or late-summer.

The surface hydrology of the bay can be divided into two distinct patterns. The northern part of the bay, including San Pablo and Suisun bays, receives freshwater outflow from the Delta and functions as part of the Estuary. The South Bay receives little runoff and behaves like a lagoon. Circulation in and flushing of the bay depend on tides and Delta outflow. Circulation is primarily a tidal process, while flushing is believed to depend on tidal action, supplemented by periodic Delta outflow surges following winter storms. The volume of water in the bay changes by about 21 percent from mean higher-high tide to mean lower-low tide. The depth of the bay averages 20 feet overall, with the Central Bay averaging 43 feet and the South Bay averaging 15 feet.

Freshwater outflow from the Delta to San Francisco Bay is believed to be important in maintaining desired environmental conditions in the bay, but no standards govern such outflow. High-volume, uncontrolled outflow surges during the winter cause freshwater to penetrate well into the central bay, from which it can enter the southern bay by tidal exchange. Such events cause salinity stratification in much of the South Bay that can persist for several weeks or months following the initial appearance of freshwater.

b. **Surface Water Quality**. Water quality in the San Francisco Bay system is impacted by several factors. For example, the presence of elevated concentrations of toxic pollutants in the bays, from both point and nonpoint sources, has caused them to be listed as impaired water bodies. The State Department of Health Services has issued health advisories on the consumption of the bays' fish and certain waterfowl due to their elevated levels of selenium and other metals.

Pesticides in the San Francisco Bay system, which pose a threat of unknown magnitude to the fisheries and wildlife resources, originate from municipal storm sewers and sanitary sewerage systems, urban runoff, and agricultural drainage from the Central Valley. Fish kills have occurred in the San Francisco Bay system as a result of accidental spills of toxic materials, and discharges of inadequately treated sewage and industrial wastes. Localized fish kills involving large numbers of striped bass have occurred in Suisun Bay from unknown causes.

The San Francisco Bay area has experienced oil pollution problems mainly localized at refinery docks, ports, marinas, and near storm sewer outlets. These problems are attributable to accidental spills, deliberate discharges, pipeline leaks, and pumping of bilge or ballast water.

Depressed levels of dissolved oxygen in the extreme portion of South San Francisco Bay occur during the late-summer and early-fall months due to municipal waste discharges. Dissolved oxygen deficiencies also occur in the Petaluma and Napa rivers. Algal growths have caused complete lack of dissolved oxygen in the extreme reaches of some tidal sloughs, creeks, and rivers. Recent years have brought red water discoloration caused by marine ciliates, a phenomenon probably aggravated by high nutrient concentrations.

Water in much of San Francisco Bay contains coliform bacteria levels greater than those recommended for water contact sports. Substantial improvement has been reported since the initiation of chlorination of the discharge from a large municipal sewerage system.

c. Groundwater Hydrology. Groundwater is found in both the alluvial basins and upland hard rock areas. Well yields in the alluvial basins range from less than 100 to over 3,000 gallons per minute. The yield from wells in the hard rock areas is generally much lower, but is usually sufficient for most domestic or livestock purposes. Recharge to the alluvial basins occurs primarily from rainfall and seepage from adjacent streams. However, a significant percentage, especially in the South Bay, is through artificial recharge facilities and incidental recharge from irrigation.

The larger alluvial basins in the North Bay area include Suisun-Fairfield, Napa-Sonoma, Petaluma, and Novato valleys. The estimated storage in these basins is 1.7 million acre-feet. The major groundwater basins of the South Bay area include the Santa Clara and Livermore valleys and the Pittsburg Plain. Total storage in the South Bay is approximately 6.5 MAF.

d. Groundwater Quality. The groundwater quality in the North Bay is generally good. Salt-water intrusion has been a problem at the lower end of the Napa and Sonoma valleys, but this has been substantially mitigated by using imported surface water instead of groundwater. Some isolated areas experience elevated levels of dissolved solids, iron, boron, hardness, and chloride. High levels of nitrates occur in the Napa and Petaluma valleys as a result of past agricultural practices. Groundwater salinity levels in the Suisun-Fairfield area typically range from 300 to 6,000 mg/l TDS, with average values generally exceeding 900 mg/l TDS. Putah Plain groundwater is of somewhat better quality, with average TDS levels generally under 600 mg/l. However, the deeper Tehama formations generally provide a higher quality of water than the overlying Putah Plains aquifer.

Groundwater quality is a problem to various degrees in some South Bay locations. The Livermore Valley has elevated of dissolved solids, chloride, boron, and hardness. The highly urbanized areas of the Santa Clara Valley have experienced groundwater pollution over large areas from organic solvents used in electronics manufacturing

5. Water Use

Total net water use for the San Francisco Bay Region in 1990 was 6,071,000 acre-feet. Seventy-nine percent (4,775,000 acre-feet) of the total use is considered environmental use. Almost all environmental water use in the region is associated with the Suisun Marsh demands and required Delta outflow. Urban water demand was 1,186,000 acre-feet (20 percent of total) and agricultural net water demand was 88,000 acre-feet.

Per capita urban water use for the region varies significantly, depending on factors such as local climate, population density, residential yard size, and volume of commercial and industrial use. The cooler coastal portions of the region have the lowest per capita water use. The low values of 100 gallons per capita per day (gpcd) in San Mateo County and 139 gpcd in San Francisco are generally related to cooler climate, small yards, and higher population densities. Santa Clara County's per capita use averages about 200 gpcd. The warmer, drier climate and greater range of lot sizes results in increased outdoor use. The county also has a mix of water-using industries, such as food processing and computer and electronics manufacturing, which tend to raise per capita use. The highest per capita urban use in the region is in Contra Costa County, where use averages 230 gpcd because many of the residential areas consist of large lots which have high landscape water requirements; there also is considerable industrial water use concentrated along the Bay. Average daily per capita water use for the San Francisco Bay region was 193 gallons in 1990. Total net urban water use is expected to increase by nearly 19 percent by 2020.

Agricultural water use is a small (1 percent) portion of the total net water demand for the region. Irrigated acreage has been reduced by 62 percent over the past 40 years. Urbanization has reduced agricultural acreage in the Santa Clara Valley from over 100,000 acres to less than 17,000 acres and Marin County has only about 700 irrigated acres remaining. Napa and Sonoma counties have actually increased agricultural acreage, due to an increase in vineyards and adoption of drip irrigation on lands too steep for furrow or sprinkler irrigation practices. Most of the agricultural lands are served by groundwater or direct diversions from the Napa River and other local streams. Irrigated acreage and net agricultural water demand are expected to increase slightly for the region, due primarily to further increases in vineyard acreage.

Suisun Marsh and Hayward Marsh are managed wetlands in the San Francisco Bay Region that have a combined water supply requirement of about 160,000 acre-feet per year. The Suisun Marsh consists of about 10,000 acres of State-owned wetlands and about 44,000 acres under private ownership and managed as duck clubs. The estimated annual water demand for Suisun Marsh is about 150,000 acre-feet. Hayward Marsh is part of the Hayward Shoreline Marsh Expansion Project, a wetland restoration project undertaken by several local agencies. As part of the project, 10,000 acre-feet of recycled water from Union Sanitary District is blended with brackish water from the Bay and applied to the 145-acre marsh to help restore habitat for fish, waterfowl, and wildlife. The largest environmental water use in the region is for Delta outflow to meet D-1485 salinity standards. The outflow requirements are for about 4.6 million acre-feet in average years and 2.9 million acre-feet in drought years.

6. Vegetation

The San Francisco Bay estuary is composed of six natural vegetation communities, including riparian, grassland, freshwater emergent wetland, saline emergent wetland, foothill woodland, and mixed chaparral. Sensitive plant species found in the San Francisco Bay region are listed in Table III-21.

Riparian habitat is typically composed of cottonwoods, sycamores, oaks, willows, blackberries, sedges, and rushes. It is generally found along perennial and intermittent waterways, flood plains, and estuarine channels. Sensitive riparian habitat in the San Francisco Bay estuary includes: great valley-valley oak riparian forest, great valley cottonwood riparian forest, great valley mixed riparian forest, white alder riparian forest, great valley willow scrub, buttonbush scrub, elderberry savanna, and central coast riparian scrub.

Grasslands are found throughout the region on the valley floor and on the well-drained slopes of the surrounding hills. Grazing and the introduction of non-native species have changed the composition to mostly annual grass species. The non-native grasslands include soft chess, red brome, wild oats, ripgut brome, and fescue. Sensitive grassland communities include coastal terrace prairie, pine bluegrass grassland, valley needlegrass grassland, serpentine bunchgrass, wildflower fields, freshwater seeps, and alkali playas.

Saline emergent wetlands are usually described as either brackish or salt marshes. Saline emergent wetlands occur in the upper intertidal zone of San Francisco and San Pablo bays, typically where wave action is reduced. The vegetation is dominated by perennial monocots along with algal mats on the soil. Two sensitive habitats in the Bay area could be grouped into the saline emergent wetland community: northern coastal salt marsh and coastal brackish marsh.

Freshwater emergent wetlands occur in a variety of topographies, so long as a basin is saturated or periodically flooded. The marshes are usually found around lakes and ponds and along river channels. Freshwater emergent wetlands are usually dominated by perennial hydrophytic monocots. Sensitive freshwater emergent wetland communities include cismontane alkali marsh, coastal and valley freshwater marsh, and vernal marsh.

Foothill woodlands are dominated by oaks and intermixed with other broad-leaved and evergreen vegetation. The woodlands are denser on the cool east and north facing slopes. Coast live oaks, the predominant species, are found higher up on the foothill slopes, above the canyon bottoms. Other trees include California buckeye, California bay, big leaf maple, and madrone. Mixed chaparral is composed of many species, including oaks, manzanita, chamise, sage, coyote brush, California buckeye, and poison oak. Chaparral and scrub communities occur on arid south-facing slopes and above woodlands. Northern maritime chaparral and serpentine chaparral are considered sensitive habitats.

Table III-21
Sensitive Plant Species in the San Francisco Bay Region

Scientific Name	Common Name	Status: State	Status: CNPS	Status: Federal
Acanthomintha duttonii	San Mateo thornmint	SE	1B	FE
Arctostaphylos hookeri ssp. *ravenii*	Presidio manzanita	SE	1B	FE
Arctostaphylos imbricata	San Bruno Mountain manzanita	SE	1B	FPT
Arctostaphylos pallida	Pallid manzanita	SE	1B	FPT
Blennosperma bakeri	Sonoma sunshine	SE	1B	FE
Calochortus tiburonensis	Tiburon mariposa lily	ST	1B	FT
Castilleja affinis ssp. *neglecta*	Tiburon Indian Paintbrush	ST	1B	FE
Ceanothus ferrisae	Coyote ceanothus		1B	FE
Ceanothus masonii	Mason's ceanothus	SR	1B	FSC
Chorizanthe robusta var. *robusta*	Robust spineflower		1B	FE
Cirsium fontinale var. *fontinale*	Fountain thistle	SE	1B	FE
Cirsium hydrophilum ssp. *hydrophilum*	Suisun thistle		1B	FPE
Clarkia franciscana	Presidio clarkia	SE	1B	FE
Cordylanthus mollis ssp. *mollis*	Soft bird's-beak	SR	1B	FPE
Cupressus abramsiana	Santa Cruz cypress	SE	1B	FE
Delphinium bakeri	Baker's larkspur	SR	1B	C
Dichanthelium lanuginosum var. *thermale*	Geyser's dichanthelium	SE	1B	FSC
Dudleya setchellii	Santa Clara Valley dudleya		1B	FE
Eriophyllum latilobum	San Mateo woolly-sunflower	SE	1B	FE
Fritillaria liliacea	Fragrant fritillary		1B	FSC
Hesperolinon congestum	Marin western flax	ST	1B	FT
Holocarpha macradenia	Santa Cruz tarplant	SE	1B	C
Lessingia germanorum	San Francisco lessingia	SE	1B	FPE
Lilaeopsis masonii	Manson's lilaeopsis	SR	1B	FSC
Pentachaeta bellidiflora	White-rayed pentachaeta	SE	1B	FE
Plagiobothrys strictus	Calistoga popcornflower	ST	1B	FPE
Poa napensis	Napa Blue grass	SE	1B	FPE
Sanicula maritima	Adobe sanicle	SR	1B	FSC
Sanicula saxitilis	Rock sanicle	SR	1B	FSC
Streptanthus albidus ssp. *albidus*	Metcalf Canyon jewelflower		1B	FE
Streptanthus niger	Tiburon jewelflower	SE	1B	FE
Suaeda californica	California seablite		1B	FE

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
CNPS: (California Native Plant Society) 1A=presumed extinct in California; 1B=rare,threatened, or endangered in California and elsewhere; 2=rare,threatened,or endangered in California but more common elsewhere; 3=need more information; 4=distribution limited (a watchlist).
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

7. Fish

The San Francisco Bay complex supports a wide variety of fish -- more than 100 fish species. Habitat types in the bay include open water, tidal mudflats, and marshland. The anadromous species of fish which occur in San Francisco Bay system include chinook salmon, striped bass, sturgeon, American shad, and steelhead trout. Marine fish, found mainly in the lower bays, include flatfish, sharks, Pacific herring, jacksmelt, topsmelt, and surf perch. Other fish in the estuary include catfish, black bass, crappie, and bluegill. Shellfish include mussels, oysters, clams, crabs, and shrimp. Threatened, endangered, or candidate fish species found in the San Francisco Bay system are listed in Table III-22.

Food supplies for San Francisco Bay estuary fish communities consist of phytoplankton, zooplankton, benthic invertebrates, insects, and fish. Seasonal variations in salinity in the bays, due to varying Delta outflows, affect the seasonal distribution of fish and invertebrates. Benthic invertebrates, such as clams, are limited to areas where conditions are favorable year-round. Once a thriving business, there is at present no commercial oyster industry in San Francisco Bay. There is sport clamming, although coliform bacteria concentrations are higher than the U.S. Public Health Service and State allowable limits.

8. Wildlife

The complex interface between land and water in the San Francisco Bay estuary provides a variety of habitats for wildlife. Large numbers of migratory waterfowl dominate the landscape, especially in Suisun Marsh. Habitats at low elevations include open water, tidal mudflats, diked and undiked marshland, and riparian vegetation; grassland, agricultural land, woodland, and chaparral can be found in upland areas.

Open water, tidal mudflats, shorelines, and marshland provide habitat for many species of waterfowl and shorebirds, including cormorants, grebes, sandpipers, plovers, rails, mallards, and pintails. Mammals commonly found in these areas include seals, sea lions, harvest mice, and shrews. These areas also support several types of amphibians and reptiles.

Species typical of uplands can be seen in the grassland, woodland, and chaparral areas. These include many types of raptors, songbirds, owls, and upland game birds, mammals such as hares, gophers, squirrels, and deer, and also reptiles.

The intense urban development in the estuary has caused destruction of much of the areas that historically provided wildlife habitat. There are currently 15 species in the estuary that are either State or Federally listed, and others are candidates for listing. Among these are the Alameda striped racer, salt marsh harvest mouse, San Francisco garter snake, California clapper rail, and California yellow-billed cuckoo. Sensitive wildlife species found in the San Francisco Bay region are listed in Table III-23.

Table III-22
Sensitive Fish Species in the San Francisco Bay Estuary

Scientific Name	Common Name	Status State	Status Federal
Acipenser medirostris	Green Sturgeon	CSC	FSC
*Eucyclogobius newberryi**	Tidewater goby	CSC	FE
Hypomesus transpacificus	Delta smelt	ST	FT
Oncorhynchus tshawytscha	Fall-run chinook salmon, Central Valley, CA ESU		C
Oncorhynchus tshawytscha	Late fall-run chinook salmon, Central Valley, CA ESU	CSC	C
Oncorhynchus tshawytscha	Spring-run chinook salmon	ST	FT
Oncorhynchus tshawytscha	Winter-run chinook salmon	SE	FE
Oncorhynchus mykiss	Steelhead, Central Valley, CA ESU		FT
Pogonichthys macrolepidotus	Sacramento splittail	CSC	FT
Spirinichus thaleichthys	Longfin smelt	CSC	FSC

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
FEDERAL: FE=endangered; FT=threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

*Believed to have been extirpated from most of its historical range in the San Francisco Bay Estuary

9. Recreation

Mild temperatures and brisk winds make San Francisco Bay a very popular recreational boating area. Other water-oriented recreation includes fishing, sightseeing, picnicking, nature walking, and camping.

The San Francisco Bay Region includes lakes and reservoirs operated by the SFWD, EBMUD, and MMWD. Those operated by SFWD are San Andreas Lake, Crystal Springs Reservoir, San Antonio Reservoir, and Calaveras Reservoir. San Pablo Reservoir, Briones Reservoir, San Leandro Reservoir, and Lake Chabot are operated by EBMUD. Nicaso Reservoir is operated by MMWD.

Because these reservoirs are used as storage facilities for municipal water supplies, access and activities are restricted. However, EBMUD allows limited non-contact water recreation usage at its lakes and reservoirs, throughout the year. Recreational facilities include fishing docks, picnic sites,

Table III-23
Sensitive Wildlife Species in the San Francisco Bay Region

Scientific Name	Common Name	Status State	Status Federal
Agelaius tricolor	Tricolored blackbird	CSC	FSC
Branta canadensis leucopareia	Aleutian Canada goose		FT
Charadrius alexandrinus nivosus	Western snowy plover	CSC	FT
Geothlypis trichos sinuosa	Saltmarsh common yellowthroat	CSC	FSC
Haliaeetus leucocephalus	Bald eagle	SE	FT
Laterallus jamaicensis coturniculus	California black rail	ST	FSC
Melospiza melodia maxillaris	Suisun song sparrow	CSC	FSC
Pelecanus occidentalis californicus	California brown pelican	SE	FE
Rallus longirostris obsoletus	California clapper rail	SE	FE
Riparia riparia	Bank swallow	ST	
Sterna antillarum browni	California least tern	SE	FE
Antozous pallidus	Pallid bat	CSC	
Eumops perotis californicus	California mastiff bat	CSC	FSC
Microtus californicus sanpabloensis	San Pablo vole	CSC	FSC
Plecotus townsendii townsendii	Townsend's western big eared bat	CSC	FSC
Reithrodontomys raviventris	Salt Marsh harvest mouse	SE	FE
Sorex ornatus sinuosus	Suisun shrew	CSC	FSC
Sorex vagrans halicoetes	Salt marsh wandering shrew	CSC	FSC
Ambystoma californiense	California tiger salamander	CSC	C
Rana aurora draytonii	California red-legged frog	CSC	FT
Clemmys marmorata	Western pond turtle	CSC	
Masticophis lateralis euryxanthus	Alameda whipsnake	ST	FPE
Thamnophis sirtalis tetrataenia	San Francisco garter snake	SE	FE
Euphydryas editha bayensis	Bay checkerspot butterfly		FT
Icaricia icarioides missionensis	Mission blue butterfly		FE
Incisalia mossii bayensis	San Bruno elfin butterfly		FE
Syncaris pacifica	California freshwater shrimp	SE	FE

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

and hiking and equestrian trails. Anderson Reservoir is owned by the SCVWD which receives CVP water. The Santa Clara County Parks and Recreation Department manage the recreation activities at the reservoir. Typical activities at the reservoir include boating, water skiing, jet skiing, and picnicking during the peak season. Off-season activities include fishing. Swimming and camping are not allowed at Anderson Reservoir. Reservoir facilities include a single boat ramp, which requires reservations for weekend use.

H. TULARE LAKE BASIN

1. Geography and Climate

The Tulare Lake Basin includes the southern San Joaquin Valley from the southern limit of the San Joaquin River watershed to the crest of the Tehachapi Mountains. It stretches from the Sierra Nevada on the east to the Coast Range on the west. Four main geographical areas make up this mostly agricultural region: the western side of the San Joaquin Valley floor and western uplands, the Sierra Nevada foothills on the region's eastern side, the central San Joaquin Valley floor, and the Kern Valley floor. The Tulare Lake region, which is shown in Figure III-15, encompasses almost 10 percent of the State's land area.

The major rivers in the region, the Kings, Kaweah, Tule, and Kern, begin in the Sierras and generally flow east to west into the San Joaquin Valley. They are sustained by snowmelt from the upper mountain elevations. All of the rivers terminate on the valley floor in lakes or sinks; water does not find its way to the ocean from the basin, as it once did under natural conditions, except during extremely wet years. The west side of the valley, the Coast Ranges, and the Tehachapis provide a large drainage area, but the streams are intermittent as there is generally scant rainfall in these areas and little runoff.

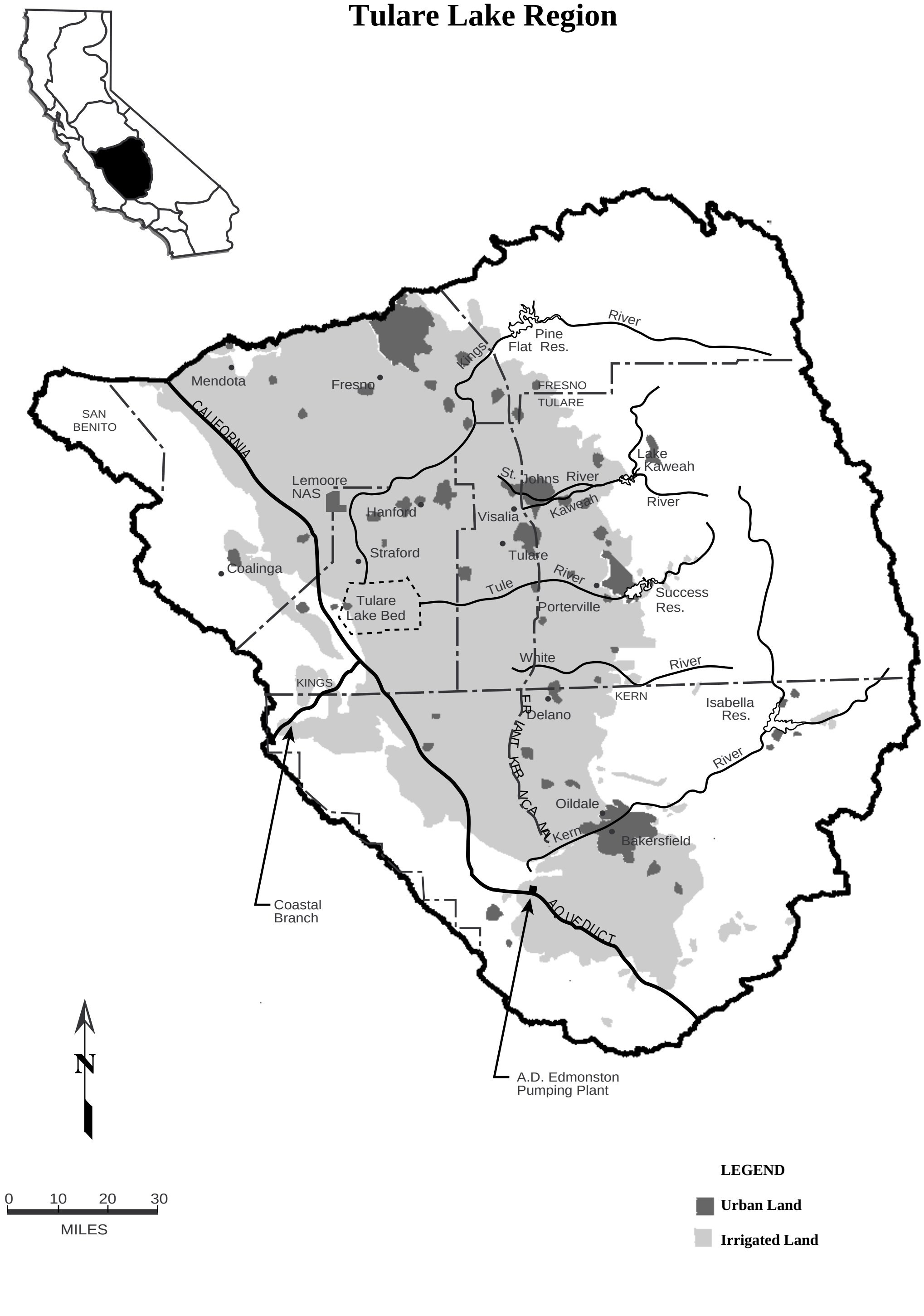
The region's climate varies between valley and foothill areas. The valley areas experience mild springs and hot, dry summers. Summer high temperatures often exceed 100EF. Winters are typically cold with some temperatures below freezing, but snowfall is rare. In some parts of the valley, thick tule fog is common at times during the winter. Climate in the foothills is typical of mountainous foothill areas where winters and springs are cold and where snowfall occurs at higher elevations.

Most of the region's winter and spring runoff from the Sierras is stored for later use in the summer to supply the drier valley floor areas. In most years, imported water from northern California supplements local supplies to meet the region's large agricultural water demand.

2. Population

The population of the Tulare Lake Region in 1990 was over 1.5 million. Many small agricultural communities dot the eastern side of the valley, but the rapidly growing cities of Fresno and Bakersfield and the Visalia-Tulare urban area anchor the region. These urban areas grew by 50 to 60 percent between 1980 and 1990. The population of the region is projected to more than double in the next 30 years, with most of the growth occurring in these same urban areas.

Figure III-15
Tulare Lake Region



Source: DWR, Bulletin 160-93 (1994)

3. Land Use and Economy

About 30 percent of the land area in the Tulare Lake Region is publicly owned, with 1.7 million acres of national forest, 0.8 million acres of national parks and recreation areas, and 0.5 million acres managed by the BLM. The publicly owned lands are primarily in the upland areas on the east side of the region and include Kings Canyon and Sequoia National Parks and Sierra National Forest.

Privately owned land totals about 7.4 million acres, of which urban areas take up 176,300 acres. Irrigated agriculture accounts for over 3.2 million acres of the private land, while other agricultural land cover an additional 1.4 million acres. The principal crops grown in the region are cotton, grapes, and deciduous fruits. Substantial acreage of almonds and pistachios are also grown, as well as increasing acreage of truck crops, such as tomatoes and corn.

In the eastern upland areas, agriculture and timber production account for most of the land use. Deciduous and citrus fruits are the main agricultural crops in the lower foothills. Timber harvesting occurs throughout many of the higher elevation areas.

4. Water Supply

The Tulare Lake Basin is one of the richest agricultural regions in the United States. The highly developed agricultural economy of the basin is dependent upon local surface runoff, import from basins to the north, and groundwater to supply its water needs.

The main local surface water supplies in the Tulare Lake Region come from the runoff from the southern Sierra Nevada rivers. Other water comes by way of the federal CVP's Delta-Mendota Canal and Friant-Kern Canal, and the SWP's California Aqueduct, which enters the region as part of the Joint-Use Facilities with the CVP's San Luis Unit. Groundwater pumping meets the remaining water demands.

Many valley cities, including Fresno and Bakersfield, rely primarily on groundwater for urban use, occasionally obtaining supplemental supplies from local surface water and some imported water. Fresno, for example, uses groundwater for its main urban supply, but also purchases local Kings River water and water from the Friant-Kern Canal and replenishes groundwater through recharge basins. In Bakersfield, the Kern County Water Agency treats CVP Cross Valley Canal water to supplement its urban groundwater supply. In isolated parts of the valley's western side, smaller cities like Avenal, Huron, and Coalinga rely on imported surface water from the San Luis Canal.

Cities in the Sierra Nevada foothills often have less dependable drought supplies than the valley communities. In many foothill areas, local surface water connections are not available and groundwater is limited to small pockets in the rock strata. A few cities, such as Lindsay and Orange Cove, receive surface water through the CVP's Friant-Kern Canal.

The SWP, through San Luis Reservoir and the California Aqueduct, provides an average of about 1.2 million acre-feet of surface water annually to the region. The USBR supplies an average of 2.7 million acre-feet during normal years from the CVP via Mendota Pool, the Friant-Kern Canal, and the San Luis Canal of the CVP/SWP San Luis Joint-Use Facilities. The Friant-Kern Canal receives water from Millerton Lake on the San Joaquin River; Mendota Pool and the California Aqueduct receive water from the Sacramento-San Joaquin Delta.

The 1990 level average water supply for the Tulare Lake Region was over 8.1 million acre-feet. Of this, about 33 percent comes from local surface supplies, 48 percent comes from the CVP and SWP (33 and 15 percent, respectively), and 19 percent comes from groundwater. The Kings-Kaweah-Tule River Planning Subarea (KKT PSA), which takes in most of the valley floor north of Kern County, accounts for just over half of the net water demand for the Tulare Lake Region. Supplies for the KKT PSA come mainly from local sources with local surface supplies providing 46 percent, groundwater providing 29 percent, and other sources providing 25 percent. The San Luis West Side and Kern Valley Floor PSAs rely more on other sources (90 and 60 percent, respectively).

a. Surface Water Hydrology. The Tulare Lake Basin is hydrologically separate from the San Joaquin River Basin and is not normally tributary to the Delta. The Kings River, which carries eroded material from the Sierra Nevada, and the Los Gatos Creek alluvial fan have built up a low, broad ridge across the trough of the valley so that the Tulare Lake Basin has essentially no natural surface water outlet.

The four major rivers in the basin, the Kings, Kaweah, Tule and Kern rivers historically drained to the Tulare Lake bed which covers about 200,000 acres. Tulare Lake tributaries are now heavily used for irrigation, with little water reaching the lake. Diversions and management of river flows have significantly reduced flow to the lake bed which remains dry except during periods of high flows in wet years. Floods are not an uncommon occurrence, but are variable in intensity and frequency. Levees have been built in the lakebed to contain the floodwater in cells and still maximize farming possibilities. During very wet periods, portions of the flow in the Kings River can enter the San Joaquin River via Fresno Slough.

Dams on the Kings, Kaweah, Tule, and Kern rivers provide flood control and water supply for groundwater recharge and for urban and agricultural uses. The Kings River, which drains the Sierra Nevada mountains in eastern Fresno County, is impounded by Pine Flat Dam and Reservoir, which stores about 1 MAF. The Kaweah River is impounded by Terminus Dam to form the 143 TAF Lake Kaweah. Success Dam impounds the Tule River to form the 82 TAF Lake Success. Lake Isabella, in Kern County, impounds water from the Kern and South Fork Kern rivers. The reservoir has a storage capacity of 570 TAF. These and other lakes and reservoirs in the Tulare Lake Region also support recreational opportunities. Table III-24 lists the major reservoirs in the Tulare Lake Basin.

Table III-24
Major Reservoirs in Tulare Lake Basin

Reservoir	River	Capacity (TAF)	Owner
Courtright	Helms Creek	123	PG&E
Wishon	Kings	128	PG&E
Pine Flat	Kings	1,000	USCOE
Lake Kaweah	Kaweah	143	USCOE
Success Lake	Tule	82	USCOE
Isabella Lake	Kern	568	USCOE

Source: DWR 1993b

b. **Surface Water Quality**. The water quality of the perennial streams which originate in the Sierra Nevada is generally very good. However, irrigation return-water forms a major portion of the summer base flow in the lower reaches of the larger streams. Saline water from oil wells is a contributor to the basin salt load. The salt content of Tulare Lake (about 570 mg/l TDS) is due mainly to soil salts historically in the basin and introduced fertilizers. Poso Creek also contributes salt to the southern portion of the basin, but the proportional quantity of water from this drainage is small.

c. **Groundwater Hydrology**. The valley floor overlies mostly one large groundwater basin that consists of alluvial sediments. In the western half to three quarters of the valley floor, the Corcoran clay layer, which is found at depths of 300 to 900 feet, divides the groundwater basin into essentially two separate aquifers. According to the SJREC, the Corcoran Clay layer is absent in much of the Kern Fan area. South of the Kern River, the Corcoran horizon drops below well depths but other clay layers provide some confinement. On the eastern side of the valley, both north and south of the Kern County line, older formations are tapped by wells that usually exceed 2,000 feet in depth. A small groundwater subbasin, with little hydraulic connection to the main aquifers, exists on the western side of Fresno, Kings, and Kern counties from Coalinga to Lost Hills. Two other subbasins in Kern County are separated from the main basin by the White Wolf and Edison faults. Productive aquifers with good quality water are the rule, except in the Tulare Lake area where lakebed clays yield little water, along the extreme eastern edge of the region where shallow depth to granite limits aquifer yields, and along the western side where water quality is poor.

The groundwater overdraft in the Tulare Lake Basin is a significant unresolved water resource problem in California. The average annual rate of groundwater overdraft was calculated to be about 650 TAF in 1990. The annual overdraft has decreased from about 1.3 MAF in 1972 due to the importation of SWP water and the availability of surplus supplies.

Numerous public and private water agencies are engaged in the acquisition, distribution, and sale of surface water to growers in the Tulare Lake Basin. Since most of the agencies overlie usable groundwater and use groundwater conjunctively with surface water, some of their operational practices, such as artificial recharge and use of surplus surface supplies in lieu of groundwater, can be viewed as elements of a groundwater management program.

d. Groundwater Quality. Groundwater in the Tulare Lake Basin ranges widely in type and concentration of chemical constituents. The differences are related to the quality of waters that replenish the groundwater reservoirs and the chemical changes that occur as the water percolates through the soil. In general, groundwater is divided into three main groups. Groundwater on the east side of the basin is generally of bicarbonate type and has low to moderate total dissolved solids. Groundwater throughout the axial trough ranges in chemical character and usually has higher total dissolved solids than the east side waters. The groundwater on the west side of the basin is of sulfate or bicarbonate type and nearly always has higher total dissolved solids than eastside groundwater.

Most groundwater in the basin is of usable quality and generally meets the needs of agricultural applications. There are areas of inferior quality groundwater, mostly occurring along the west side of the valley. Naturally occurring constituents that limit the usefulness of groundwater in these areas include total dissolved solids, sulfate, boron, arsenic, chloride, selenium, and uranium.

Groundwater near Tulare Lake has experienced an increase in dissolved solids concentrations over the years. Groundwater quality has suffered due to the agricultural practice of leaching salts from the root zone into shallow groundwater. In some locations, beneficial use of groundwater has been impaired as a result of quality degradation from salt loading.

Most of the region's urban population relies on groundwater to meet its water demands. Drinking water standards are much stricter than agricultural requirements and many of the urban areas are faced with water quality problems from their groundwater supplies. The groundwater in some areas of the basin exceeds the recommended TDS concentration limit in the U.S. Public Health Service Drinking Water Standard (500 mg/l). Nitrogen concentrations in some groundwater in the Tulare Lake Basin approach or exceed the levels recommended by the drinking water standards (10 mg/l). High nitrogen concentrations are usually attributed to sewage effluent, fertilizers, feedlots and dairies. Herbicides and pesticides from agricultural applications, as well as petroleum products and industrial solvents, are being discovered in excess of the maximum contamination limits in various areas throughout the basin.

5. Water Use

Water supplies in the Tulare Lake Region are mostly used for irrigated agriculture. With 1990 level average conditions, irrigated agriculture uses over 7.7 million acre-feet, which is about 95 percent of the region's total water use. Cotton accounts for 35 percent of the total evapotranspiration of applied water for irrigated crops. Municipal and industrial needs are about 214,000 acre-feet per year (3 percent of total). Average per capita daily water use within the region is about 301 gallons. Municipal and industrial net water use is expected to increase 112 percent by 2020 due to large population increases throughout the region, while agricultural water use may decline by over

0.5 million acre-feet (7 percent) as farm irrigation efficiencies continue to increase and some agricultural land is converted to urban use.

6. Vegetation

Ten common natural vegetation community types occur in the Tulare Lake Basin. They include valley and foothill riparian, valley grassland, freshwater emergent wetland, foothill woodland, valley oak woodland, sycamore alluvial woodland, mixed chaparral, and chenopod scrub. Mixed conifer forest, montane hardwood, and montane riparian vegetation communities typical of the Sierra Nevada are found in the eastern portion of the region. Chaparral is the most abundant natural community in the basin occurring on the foothill and mountain slopes surrounding the valley floor.

Plant species along the major tributaries to the basin are typical of those found in the riparian habitats throughout the west slope of the Sierra Nevada foothills. Around streams and lakes, riparian habitats include willows, western sycamore, cottonwood, alder, and California buckeye, as well as shrubs and herbaceous species. Sensitive riparian habitats in the Tulare Lake Basin include great valley-valley oak riparian forest, great valley cottonwood riparian forest, great valley mixed riparian forest, white alder riparian forest, great valley willow scrub, buttonbush scrub, elderberry savanna, central coast cottonwood-sycamore riparian forest, central coast live oak riparian forest, central coast arroyo willow riparian forest, and great valley mesquite scrub.

A large part of the riparian vegetation, including areas below the reservoirs, has been lost due to extensive agricultural encroachment and other development. However, there is a mature riparian forest on both sides of the Kaweah River immediately below Terminus Dam. Most natural vegetation below the reservoirs remains only in small disjunct patches. Further downstream, plant life becomes similar to that of the Tulare Lake Basin. Plant life of the lower Kern River is characterized as valley mesquite habitat, which is uniquely found in southwestern Kern County.

Grassland is a broadly defined community, occupying the perimeter of the valley portion of the region. Although valley grassland historically consisted of perennial bunch grasses, grazing and the introduction of non-native species have changed the composition to mostly annual grass species. Vernal pools are found among many of the grassland areas. Sensitive grassland habitat types in the Tulare Lake Basin, in addition to the vernal pools, include valley needlegrass grassland, serpentine bunchgrass, wildflower fields, freshwater seeps, alkali playas, pine bluegrass grassland, and valley sacaton grassland.

Historically, the Tulare Lake Basin contained the largest single block of wetland habitat present in California. Cattail-sedge species such as tule cattail and spike rush occur throughout the region in fresh and brackish marshes, farm ponds, and ditches. Diversion of water for agricultural and urban uses resulted in the reclamation of Tulare Lake and associated wetlands. Less than 1 percent of the freshwater lake habitat and 4 percent of the wetland habitat remains. Three sensitive freshwater emergent wetland communities occur in the Tulare Lake Basin: cismontane alkali marsh, coastal and valley freshwater marsh, and vernal marsh.

The foothill woodland community type occurs in the foothills and valley borders, usually between 500 and 3,000 feet in elevation. It is typically dominated by one or more species of oaks in association with pines, California buckeye, Ceanothus species, manzanita, and annual grasses. Two subsets of this community type are blue oak woodland, found on the lower slopes of the foothills surrounding the Central Valley, and blue oak-foothill pine woodland, found at slightly higher elevation. Throughout California over the past 25 years, oak woodlands (both foothill and valley) have been lost at a rate of almost 14,000 acres annually to residential and commercial development.

Patches of valley oak woodland occur in the Sacramento and San Joaquin valleys, in the Tehachapi Mountains, and in the valleys of the Coast Ranges. This community type is dominated by valley oak, with species such as sycamore, walnut, interior live oak, poison oak, and blackberry also commonly present. Although valley oak woodland can occur up to elevations of 2,000 feet, it is usually found in the well-drained alluvial soils of valley bottoms.

Sycamore alluvial woodland is a sensitive community that occurs in the southern Coast Ranges and in the Sierra Nevada foothills, from Alameda to Santa Barbara counties. This community type is found along intermittent streams. Rainfall rather than snowmelt usually produce flow in these streams. Sycamore alluvial woodland consists of a winter-deciduous broadleafed riparian woodland with widely spaced sycamores, California buckeyes, and elderberry bushes.

Mixed chaparral can be found in the Coast Ranges and along the lower slopes of the western Sierra Nevada. It usually does not occur above 5,000 feet elevation. This vegetation community is composed of many species, including oaks, manzanita, chamise, California buckeye, and poison oak. Structurally, mixed chaparral is a brushland with the canopy height varying from 3 to 13 feet. Sensitive chaparral habitats in the Tulare Lake Basin are serpentine chaparral and upper Sonoran subshrub scrub.

Chenopod scrub is a broad community type that includes valley, foothill, and desert habitats. The Sacramento and San Joaquin valleys once contained many examples of the various types of foothill and valley chenopod scrubs, but as a result of flood control, agriculture, and groundwater pumping, most of these communities are now limited in their distribution. Chenopod scrub communities consist of shrubby, often succulent species, typically dominated by the Chenopodiaceae family. They occur on poorly drained soils, dry lakebeds, and alluvial fans, often in alkaline or saline soils. Valley sink scrub, valley saltbush scrub, interior coast range saltbush scrub, and Sierra-Tehachapi saltbush scrub are particularly sensitive community types.

The majority of special-status wildlife species are associated with the grasslands, freshwater emergent wetlands and open water habitats that occur on the valley floor. The Tulare Lake Basin contains 106 significant natural areas which contain habitat for many special-status plant and animal species. Sensitive plant species found in the Tulare Lake Basin are listed in Table III-25.

7. Fish

Water diversions, channelization, and construction of irrigation canals and levees have dramatically altered aquatic and riparian habitats in the Tulare Lake area. The vast lakebottom and marsh areas of Tulare Lake and much of its native flora and fauna have been replaced by agriculture. Normal irrigation and farming practices dictate that these irrigation canals often dry up seasonally. In spite of this, several species of fish occur seasonally or perennially when there is water in Tulare Lake, usually only in above-normal water years.

Native fish species include rainbow trout, tule perch, Sacramento sucker, riffle sculpin, and endemic minnows. Recently, neither Sacramento perch nor tule perch has been reported from the drainage, and the extent and diversity of native minnow populations have diminished. Non-native species of both game and nongame fish have been introduced throughout the basin.
Principal game fish in tributaries upstream of the dams are rainbow and brown trout, smallmouth bass, bluegill, and green sunfish. In the reservoirs, the coldwater fishery consists mainly of planted rainbow trout. Largemouth bass, bluegill, redear sunfish, black crappie, and white catfish dominate the warmwater fishery.

Fish habitat downstream from tributary reservoirs is primarily warm water. Trout move out of the lakes and support a trout fishery immediately below some of the dams during fall and winter. Summer water temperatures in these reaches are too warm to sustain coldwater species year round. The rivers are commonly dewatered when there are no irrigation or flood control needs, so fish are seasonal and are usually from upstream areas. When intermittent pools exist, the more hearty and well-adapted species such as carp, Sacramento blackfish, bullhead, green sunfish, bluegill, mosquitofish, hitch, golden shiner, log perch, and Mississippi silverside can usually be found.

The Tulare Lake Basin is not inhabited by any threatened or endangered fish species, but the Kern Brook lamprey is a State listed species of special concern. There also are no species of commercial importance in the basin, although recreational fishing is quite popular, and a variety of coldwater and warmwater game fish are available.

8. Wildlife

A majority of the native wildlife has been extirpated from the Tulare Lake Basin. Many species that occurred historically in the lake basin have been greatly reduced in number due to habitat deterioration and destruction from farming and urban development in the area. A number of wildlife species have been able to adapt to the conversion of grassland community to cultivated lands. These converted lands support large populations of rodents that provide prey for raptors and other wildlife that include rodents in their diet. Other species that have adapted successfully to an agricultural environment include brush rabbits, beechy ground squirrels, white-crowned sparrows, mourning doves, American goldfinches, and house finches. Migratory waterfowl utilize open pastures, harvested fields, and the Goose and Buena Vista Lakes for fall and winter feeding.

Table III-25
Sensitive Plant Species in the Tulare Lake Basin

Scientific Name	Common Name	Status State	Status CNPS	Status Federal
Atriplex tularensis	Bakersfield smallscale	SE	1B	FSC
Brodiaea insignis	Kaweah brodiaea	SE	1B	FSC
Castilleja campestris ssp.*succulenta*	Succulant owl's-clover	SE	1B	FT
Caulanthus californicus	California jewelflower	SE	1B	FE
Chamaesyce hooveri	Hoover's spurge		1B	FT
Cordylanthus palmatus	Palmate-bracted bird's-beak	SE	1B	FE
Eremalche kernensis	Kern mallow		1B	FE
Eriastrum hooveri	Hoover's eriastrum		4	FT
Fritillaria striata	Striped adobe-lily	ST	1	FPT
Gratiola heterosepala	Boggs Lake hedge-hyssop	SE	1B	
Lembertia congdonii	San Joaquin woollythreads		1B	FE
Opuntia basilaris var. treleasei	Bakersfield cactus	SE	1B	FE
Orcuttia inaequalis	San Joaquin Valley Orcutt grass	SE	1B	FT
Pseudobahia bahiifolia	Hartweg's golden sunburst	SE	1B	FE
Pseudobahia peirsonii	San Joaquin adobe sunburst	SE	1B	FT
Tuctoria greenei	Greene's tuctoria	SR	1B	FE

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
CNPS: (California Native Plant Society) 1A=presumed extinct in California; 1B=rare,threatened, or endangered in California and elsewhere; 2=rare,threatened,or endangered in California but more common elsewhere; 3=need more information; 4=distribution limited (a watchlist).
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

A wide variety of wildlife species inhabit the tributary drainages; among them are California mule deer, mountain lion, golden eagle, coyote, and bobcat. Farther downstream, wildlife typical of the low Sierra Nevada foothills becomes less prevalent and species more typical of the valley floor become more numerous. Species common in the lower elevations include valley quail, band-tailed pigeon, dove, osprey, and red-tailed hawk. Wild turkeys have recently been established near the boundary of Sequoia National Park.

A number of threatened or endangered species may occur within the area, including the Sierra red fox, California wolverine, San Joaquin kit fox, San Joaquin antelope squirrel, blunt-nosed leopard lizard, Tipton kangaroo rat, giant kangaroo rat, giant garter snake, peregrine falcon, Swainson's hawk, black-shouldered kite, great blue heron, western snowy plover and spotted owl. Bald eagles frequently winter along the lower reaches, and at one time, the endangered California condor occasionally ranged over the drainage during late summer. The yellow-billed cuckoo has not been reported in this area for a number of years though it was formerly widespread in San Joaquin Valley riparian areas. Its disappearance from the area is probably due to the lack of adequate habitat since it requires relatively large areas of undisturbed riparian areas. Sensitive wildlife species in the Tulare Lake Basin are listed in Table III-26.

9. Recreation

Some water use in recreation areas can be described as indirect usage. Along the California Aqueduct, there are many areas designated for fishing that include easy access from area roads and vehicle parking areas. In the Tulare Lake Region, there are five fishing access areas: Three Rocks, Huron, Kettleman City, Lost Hills, and Buttonwillow. In the foothills, the major reservoirs have recreation areas that are used for fishing, boating, camping, and other recreational uses. Both fishing access and recreation areas show reduced use during drought periods and low-flow months.

During years of normal runoff, white water rafting is a popular activity on the upper Kings and Kern rivers. Stretches of these rivers have been declared wild and scenic by federal legislation. The Kings River is designated as such on both the middle and south fork of the upper portion above Mill Flat Creek. The Kern River is designated wild and scenic on both the north and south fork of the upper portion above Isabella Lake.

The remaining wetlands in the region are mainly freshwater wetlands that provide habitat for migratory waterfowl. These wetlands include the Kern and Pixley NWRs, the Mendota Wildlife Area, and the Tulare lakebed. The Mendota Wildlife Area, which is a regulating basin for the Delta-Mendota Canal, receives about 23,000 acre-feet per year. The Kern NWR has no firm supplies and relies on surplus water from the SWP and groundwater. Pixley NWR has no firm supplies and relies on flood flows from Deer Creek and groundwater.

The Tulare Lake Region has approximately 40 private hunting clubs that encompass over 15,000 acres. In 1990, there were nearly 3,000 acres of privately managed wetlands, including duck clubs, nature preserves owned by nonprofit organizations, and rice lands. In average years, about 7,000 acre-feet of water is supplied to duck club properties.

I. CENTRAL COAST REGION

1. Geography and Climate

The Central Coast Region accounts for about 7 percent of California's total land area. It encompasses the area adjacent to the Pacific Ocean from Santa Cruz County in the north through Santa Barbara County in the south and includes a number of mountain ranges that make up the central portion of the Coast Ranges. The region includes the Pajaro, Carmel, Santa Maria, Cuyama, and Salinas valleys, and the rugged coastline features Monterey Bay and Morro Bay. The Central Coast region, shown in Figure III-16, consists of three broad physiographic regions, including coastal plains, coastal mountains and valleys, and interior mountains and valleys.

Table III-26

Sensitive Wildlife Species in the Tulare Lake Basin

Scientific Name	Common Name	Status State	Status Federal
Accipiter cooperi	Cooper's hawk	CSC	
Accipiter striatus	Sharp-shinned hawk	CSC	
Agelaius tricolor	Tricolored blackbird	CSC	FSC
Aquila chrysaetos	Golden eagle	CSC	
Asio flammeus	Short-eared owl	CSC	
Athene cunicularia	Burrowing owl	CSC	
Buteo swainsoni	Swainson's hawk	ST	
Charadrius alexandrinus nivosus	Western snowy plover	CSC	FT
Circus cyaneus	Northern harrier	CSC	
Coccyzus americanus occidentalis	Western yellow-billed cuckoo	SE	
Empidonax traillii	Willow flycatcher	SE	
Falco mexicanus	Prairie falcon	CSC	
Grus canadensis tabida	Greater sandhill crane	ST	
Gymnogyps californianus	California condor	SE	FE
Haliaeetus leucocephalus	Bald eagle	SE	FT
Icteria virens	Yellow-breasted chat	CSC	
Pandion haliaetus	Osprey	CSC	
Plegadis chihi	White-faced ibis	CSC	FSC
Riparia riparia	Bank swallow	ST	
Vireo bellii pusillus	Least Bell's vireo	SE	
Ammospermophilus nelsoni	San Joaquin antelope squirrel	ST	FSC
Antrozous pallidus	Pallid bat	CSC	
Dipodomys ingens	Giant kangaroo rat	SE	FE
Dipodomys ingens brevinasus	Short-nosed kangaroo rat	CSC	
Dipodomys nitratoides nitratoides	Tipton kangaroo rat	SE	FE
Euderma maculatum	Spotted bat	CSC	FSC
Eumops perotis californicus	California mastiff bat	CSC	FSC
Neotoma fuscipes riparia	Riparian woodrat	CSC	C
Onychomys torridus tularensis	Tulare grasshopper mouse	CSC	
Plecotus townsendii townsendii	Townsend's western big-eared bat	CSC	
Sorex ornatus relictus	Buena Vista Lake shrew	CSC	C
Vulpes macrotis mutica	San Joaquin kit fox	ST	FE
Clemmys marmorata	Western pond turtle	CSC	
Gambelia sila	Blunt-nosed leopard lizard	SE	FE
Thamnophis gigas	Giant garter snake	ST	FT
Ambystoma californiense	California tiger salamander	CSC	C
Rana aurora draytonii	California red-legged frog	CSC	FT
Rana boylii	Foothill yellow-legged frog	CSC	FSC
Scaphiopus hammondii	Western spadefoot toad	CSC	FSC
Branchinecta longiantenna	Longhorn fairy shrimp		FE
Branchinecta lynchi	Vernal pool fairy shrimp		FT
Desmocerus californicus dimorphus	Valley elderberry longhorn beetle		FT

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.
Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

The varied geography of the region creates diverse climates. During the summer months, temperatures are generally cool along the coastline and warm inland. In the winter, temperatures remain cool along the coast and become even cooler inland.

Annual precipitation in the northern region ranges from 14 to 45 inches, usually in the form of rain, with most it occurring from November through April. The average annual precipitation near the City of Salinas is about 14 inches while in the higher elevations of the Big Sur area south of Monterey, precipitation averages about 40 inches per year. Average annual precipitation in the southern coastal basins ranges from 12 to 20 inches. The southern interior basins usually receive from 5 to 10 inches per year, with the mountain areas receiving more than the valley floors.

2. Population

With a 1990 population slightly under 1.3 million, the Central Coast Region contains roughly 4 percent of California's total population. Growth in this region from 1980 to 1990 exceeded the State's average. The collective population of incorporated cities in the Salinas Valley increased 37 percent, and population centers such as San Luis Obispo and Santa Maria had increases of 23 and 54 percent, respectively.

Despite population increases, much of the region is sparsely populated. The principal population centers are Santa Cruz, Salinas, Watsonville, Monterey, San Luis Obispo, Santa Maria, Santa Barbara, and Lompoc.

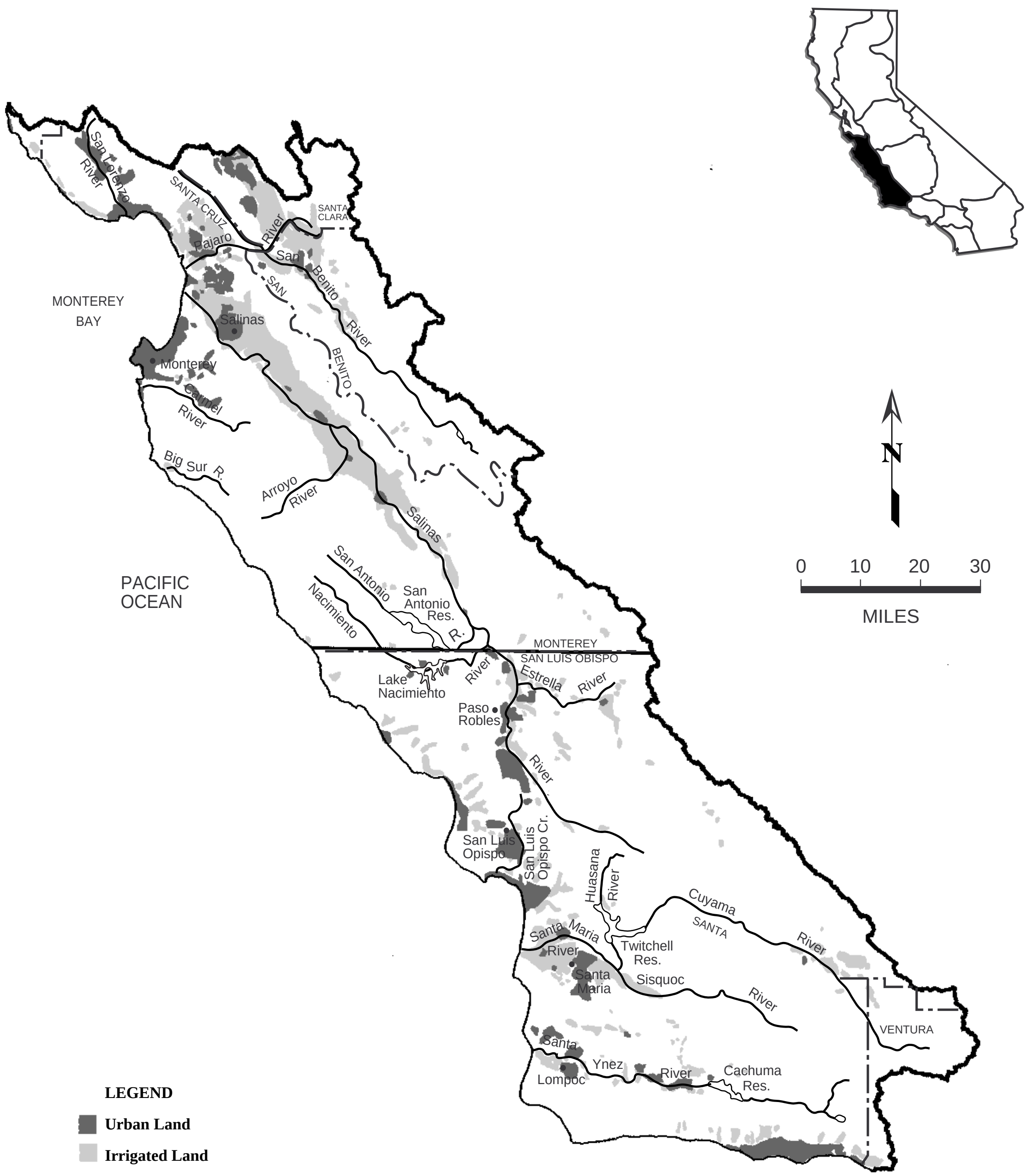
3. Land Use and Economy

The economy of several areas of the region is tied to military installations. Fort Ord, Hunter-Liggett Military Reservation, Camp Roberts, and Vandenberg AFB are the major military facilities in the region, although Fort Ord was recently closed.

Publicly owned lands constitute approximately 28 percent of the region's area. The four major military installations within the region occupy 340,000 acres. State parks and national forests provide about 1.3 million acres for public recreation. Elkhorn Slough National Estuarine Research Reserve is one of the few remaining coastal wetlands. The slough is on a migratory flyway and is an important feeding and resting ground for waterfowl.

Irrigated and nonirrigated agriculture remain the dominant land use for most of the Central Coast region. Intensive agriculture exists in the Salinas and Pajaro valleys in the north and the Santa Maria and lower Santa Ynez valleys in the south. Moderate levels of agricultural activity also occur near the upper Salinas, South Coast, and Cuyama areas. Most of the region's irrigated agriculture is in the northern and southwestern valleys, and irrigated acreage has decreased slightly in recent years as a result of urban encroachment.

Figure III-16
Central Coast Region



Source: DWR, Bulletin 160-93 (1994)

Vegetables and other truck crops are the primary crops grown in the region, with many acres planted in vineyards and orchards. Cut flowers, strawberries, and specialty crops, such as asparagus, mushrooms, artichokes, and holly, are distinctive to the northern region. The flower seed industry is important in Lompoc Valley and also attracts many tourists. Portions of the upper Salinas Valley and Carrizo Plain are dry-farmed to produce winter grain. These areas also support sheep and cattle ranching. Manufacturing is limited, but heavy water-using industries, such as petroleum production and refining, food processing, and stone, clay, and glass products manufacturing are present.

4. Water Supply

Groundwater is the primary source of water for the region. The average water supply for the 1990 level of development is about 1.1 million acre-feet. In 1990, groundwater pumping amounted to 82 percent of total supplies, 21 percent of which was in excess of the estimated prime supply and is considered overdraft.

Currently, imported supplies account for only 5 percent of the total water supply. This water is delivered to the northern part of the region from the CVP through the San Felipe Project. Completion of the Coastal Branch of the SWP in 1997 has lessened the reliance on groundwater supplies in San Luis Obispo and Santa Barbara counties. The Coastal Branch facilities are expected to transport 52.7 TAF of water to the area, though full SWP entitlement is 70.5 TAF per year for these areas. Santa Barbara County has the option to buy back an additional 12.2 TAF per year of SWP water.

a. Surface Water Hydrology. The Santa Ynez, Santa Maria, and Salinas rivers constitute the major drainages of the Central Coast region, although numerous lesser streams exist. There are in excess of 60 reservoirs, most of which are privately owned. The reservoirs in the region are used for residential and municipal water needs, flood control, recreation, irrigation, and riparian habitat. Table III-27 lists the major reservoirs in the Central Coast Region.

The Salinas River, the largest single watershed in the Central Coast area, flows northward through Monterey County to Monterey Bay. San Antonio and Nacimiento Reservoirs store and regulate the flows on the major tributaries to the Salinas River which, together with the Carmel and Pajaro rivers, provide most of the groundwater recharge for the northern part of the region. Smaller watersheds in the northern part of the region include San Luis, Chorro, San Juan, and Arroyo Grande creeks.

Basins in the southern part of the region are smaller, but locally important. The Santa Maria River and its Cuyama River tributary form the boundary between San Luis Obispo and Santa Barbara counties. Twitchell Reservoir is located on the Cuyama River. The Sisquouc River, tributary to the Santa Maria River, is listed as a federal Wild and Scenic River. The Santa Ynez River drains the southern portion of Santa Barbara County with Lake Cachuma as the primary storage facility. Salsipuedes Creek is a major stream in the Santa Ynez Valley. Lesser streams include San

Antonio, Alisal, Alamo Pintado, and Santa Aqueda creeks, Atascadero Creek in Goleta, Mission and Sycamore creeks in the city of Santa Barbara, and Santa Monica, Steer, and Rincon creeks in the Carpinteria area.

Table III-27
Major Reservoirs in the Central Coast Region

Reservoir	River	Capacity (TAF)	Owner
Santa Margarita Lake	Salinas	24	USACE
San Antonio	San Antonio	335	MCWRA
Nacimiento	Nacimiento	340	MCWRA
Gibralter	Santa Ynez	9	City of Santa Barbara
Cachuma (Bradbury)	Santa Ynez	190	USBR
Whale Rock	Old Creek	41	DWR
Lopez	Arroyo Grande Creek	52	SLOCFCWCD
Vaquero (Twitchell)	Cuyama River	240	USBR

Source: DWR 1993b

b. <u>Surface Water Quality</u>. The population of the Central Coast has grown substantially in the past few decades, and surface water of adequate quality is now in short supply. Water quality problems are not often evident, although bacterial contamination of coastal waters has been noted in Morro Bay and southern Santa Barbara County. Other streams in the Central Coast area, such as the Cuyama River, are highly mineralized (above 1000 milligrams/liter total dissolved solids), which contributes to high groundwater salinity.

Water quality of streams in San Luis Obispo County typically varies from good (water that supports and enhances the designated beneficial uses) to intermediate (water that supports designated beneficial uses but is degraded occasionally). However, some streams contain water of impaired quality (water that cannot reasonably be expected to attain or maintain applicable water quality standards). The Salinas River has about 120 miles of good water quality, 30 miles of intermediate, and 30 miles of impaired. Water quality problems are caused by agricultural return flows that carry toxic organics. San Luis Obispo Creek contains 8 miles of good water quality and 10 miles of impaired. Water quality problems are caused by sedimentation, which has led to impaired spawning habitat and a decline in the fishery. Lower San Luis Obispo Creek experiences eutrophication problems. Santa Rosa Creek consists of 12 miles of intermediate quality water. This may be a result of natural nickel, chromium, and mercury in the water and in streambed sediments. The Cuyama River, which runs through both San Luis Obispo and Santa Barbara counties, has 91 miles of intermediate water quality. Below Twitchell Reservoir, the river contains elevated levels of NO_3, SO_4 and total dissolved solids. Chorro Creek has 3 miles of intermediate quality water and 8 miles of impaired water. Inactive mines and sedimentation contribute to the water quality problems.

Major streams in Santa Barbara County typically have water of intermediate or impaired quality. Rincon Creek consists of 9 miles of intermediate water quality, principally caused by sedimentation problems. Santa Monica Creek, with pesticides present in stream sediments, has 4 miles of intermediate water quality. The Sisquouc River has 45 miles of river with intermediate quality and has only seasonal flow, with sedimentation problems. The Santa Ynez River has 59 river miles of intermediate water quality and 11 miles of impaired quality. Coliform, conductivity, and excessive total dissolved solids have contributed to the water quality problems. Mission Creek contains 9 miles of stream with impaired water quality. Coliform levels cause some of the water quality problems, and runoff is also suspected to contain metals and organics.

Half of the major reservoirs in the Central Coast area contain water of unknown quality (Vaquero/Twitchell, Santa Margarita, Lopez, and Whale Rock). Jameson Reservoir is characterized as having good water quality, as are Lake Cachuma and Gibraltar Reservoir, which also have limited sedimentation problems. Additionally, Gibraltar Reservoir contains mercury mine tailings. Lake Nacimiento contains water of impaired quality, as evidenced by elevated levels of toxic substances in fish tissue levels.

c. Groundwater Hydrology. There are approximately 53 groundwater basins, subbasins, and storage areas in the Central Coast Region. Most of the groundwater basins are small but important to their local communities. These shallow basins underlie seasonal coastal streams. During years with normal or above-normal rainfall, aquifers in the basins are continuously replenished by creek flows. In years of below-normal precipitation, the creek flows are intermittent, flow is insufficient for both agriculture and municipal uses, wells become dry, and seawater intrudes into some coastal groundwater basins.

There are nine groundwater basins in San Luis Obispo County, some of which are shared with Monterey and Santa Barbara counties. The nine basins are Paso Robles Basin, Cholame Valley, Los Osos Valley, San Luis Obispo Valley, Pismo Creek Valley, Arroyo Grande Valley-Nipomo Mesa area, Santa Maria River Valley, Cuyama Valley, and Carrizo Plain. Pismo Creek Valley (10 square miles) is the smallest, and Paso Robles Basin (860 square miles) is the largest. Storage capacity of the nine basins ranges from 30,000 acre-feet to 6,800,000 acre-feet, and usable capacity ranges from 10,000 acre-feet to 1,700,000 acre-feet.

Santa Barbara County has seven identified groundwater basins, including those that are shared with San Luis Obispo and Ventura counties. The seven basins are Santa Maria River Valley, Cuyama Valley, San Antonio Creek Valley, Santa Ynez River Valley, Goleta Basin, Santa Barbara Basin, and Carpinteria Basin. Carpinteria Basin (12 square miles) is the smallest, and Santa Ynez River Valley (260 square miles) is the largest. The storage capacity of these basins ranges from 140,000 acre-feet to 2,700,000 acre-feet and the usable capacity ranges from 19,000 acre-feet to 362,000 acre-feet.

The Cuyama Valley basin is subject to critical conditions of overdraft because extraction, evapotranspiration, and outflow outpace natural groundwater recharge. Irrigation water use in the basin increased 53,000 acre-feet between 1939 and 1980. Groundwater levels in the western and central parts of the valley declined from 50 to 200 feet between 1950 and 1980, and the loss of groundwater storage capacity between 1947 and 1978 was 700,000 acre-feet.

d. Groundwater Quality. Water quality in the Central Coast Region is generally quite good. Groundwater temperature ranges from about 55EF to about 75EF. TDS content of the water is generally less than 800 milligrams per liter, but locally it can be more than 11,000 milligrams per liter. The predominant water type is calcium bicarbonate; however, sodium, magnesium, sulfate, and chloride are present locally in significant quantities.

In San Luis Obispo County, most groundwater basins have only minor water quality problems. The Paso Robles Basin has locally high levels of boron for irrigation use, and the Los Osos Valley has some areas of sea water intrusion, as well as locally high levels of chlorides for domestic or irrigation uses and for prevention of seawater intrusion. Along the coastal margin of Pismo Creek Valley, TDS, chloride, and sulfate are high for domestic use, and locally, in the Pismo basin, TDS and nitrates are high for domestic use. The lower Arroyo Grande Valley commonly has high nitrates for domestic use, and along the coastal margin TDS, chlorides, and sulfates are high for domestic uses. The Santa Maria River Valley is locally high in TDS for domestic use. The Cuyama Valley has local areas of groundwater that are unsuitable for domestic or irrigation use, and near Soda Lake in the Carrizo Plain, the groundwater is generally unsuitable for domestic and irrigation uses.

In Santa Barbara County, the San Antonio Creek and Santa Ynez River valleys are locally high in TDS for domestic and irrigation use. In the Goleta Basin, there are locally high levels of TDS, manganese, and iron for domestic use. In the Santa Barbara Basin, TDS is high for domestic use and boron and chlorides are also high, and seawater is possibly intruding into the basin. The Carpinteria Basin also has possible seawater intrusion.

5. Water Use

In 1990, the total net water use was 1,143,000 acre-feet. Agricultural water use accounted for 78 percent of the total water use in the region, while urban water use was 20 percent of the total. Energy production, environmental needs, conveyance losses, and recreation make up the remainder of total water use. Forecasts indicate that average annual water demand will increase by about 13 percent by 2020.

Urban net water demand for the region in 1990 was 229,000 acre-feet. The average per capita water use in the Santa Barbara and San Luis Obispo areas was 187 and 190 gallons, respectively. These values reflect the average use for the region, which includes highs of about 250 gallons per day in the warmer inland communities of Hollister and King City and lows of about 150 gallons per day in the chronically water-short, but cooler Monterey-Carmel area. While population in the Central Coast is expected to increase by about 56 percent by 2020 to over 2 million people, the urban water use in the region is not projected to increase proportionally.

Irrigated agriculture has remained relatively stable in the Central Coast Region during the past decade and is forecasted to increase just slightly by 2020. Irrigated crop acreage in 1990 was

528,000 acres and the total applied water demand was 1,140,000 acre-feet. Total agricultural net water demand was 893,000 acre-feet.

6. Vegetation

Much of the natural vegetation in the Central Coast Region remains relatively undisturbed. Those areas that have been developed have mainly been the valleys, alluvial fans and plains, and terraces. Vegetation found in the Central Coast service area can be divided into a number of broad categories, or vegetation communities. These communities contain both native and non-native species.

Plant communities found in the area include valley and foothill riparian, grassland, freshwater emergent wetland, saline emergent wetland, foothill woodland, sycamore alluvial woodland, mixed chaparral, chenopod scrub, coastal scrub, coastal dunes, coast live oak forest, montane hardwood forest, and mixed conifer forest. Numerous sensitive plant species occur in these communities. Sensitive plant species found in the Central Coast region are listed in Table III-28.

Sensitive riparian habitats in the Central Coast region include central coast live oak riparian forest, central coast cottonwood-sycamore riparian forest, central coast arroyo willow riparian forest, and central coast riparian scrub. Sensitive grassland habitats include vernal pools, serpentine bunchgrass, pine bluegrass grassland, wildflower fields, and freshwater seeps. Sensitive wetland habitats include coastal and valley freshwater marsh, vernal marsh, northern coastal salt marsh and coastal brackish marsh. Other sensitive habitats that are found in the Central Coast region include central maritime chaparral, interior coast range saltbush scrub, and central dune scrub.

7. Fish

A wide variety of fish, including both warmwater and coldwater species, can be found in the streams and reservoirs of the Central Coast area. Threespine stickleback, sculpin, speckled dace, and Sacramento squawfish can be found in many of the streams. Some streams have runs of steelhead or populations of tidewater gobies. Most reservoirs contain populations of brown bullhead, bluegill, white catfish, channel catfish, smallmouth bass, largemouth bass, threadfin shad, and black crappie. Golden shiner, red-eared sunfish, trout (planted), Alabama bass, striped bass, and spotted bass are also found in some reservoirs. San Antonio Reservoir has a commercial fishery for carp and goldfish. Whale Rock Reservoir contains a population of landlocked steelhead, while California's only legal population of white bass is found in Nacimiento Reservoir.

No species of salmon are found in the streams south of Monterey Bay. However, three other significant fish species are found along the central coast streams, including winter run steelhead, tidewater goby, and the unarmored threespine stickleback. Sensitive fish species found in the Central Coast region are listed in Table III-29.

Table III-28

Sensitive Plant Species in the Central Coast Region

Scientific Name	Common Name	Status State	Status CNPS	Status Federal
Arctostaphylos hookeri ssp. *hearstorium*	Hearst's manzanita	SE	1B	FSC
Arctostaphylos morroensis	Morro manzanita		1B	FT
Arenaria paludicola	Marsh sandwort	SE	1B	FE
Bloomeria humilis	Dwarf goldenstar	SR	1B	FSC
Castilleja mollis	Soft-leaved Indian paintbrush		1B	FPE
Caulanthus californicus	California jewelflower	SE	1B	FE
Ceanothus hearstorium	Hearst's ceanothus	SR	1B	FSC
Ceanothus maritimus	Maritime ceanothus	SR	1B	FSC
Chlorogalum purpureum var.reductum	Camatta Canyon amole	SR	1B	C
Cirsium fontinale var. *obispoensis*	Chorro Creek bog thistle	SE	1B	FE
Cirsium loncholepis	La Graciosa thistle	ST	1B	C
Cirsium rhothophilum	Surf thistle	ST	1B	C
Clarkia speciosa ssp. *immaculata*	Pismo clarkia	SR	1B	FE
Crodylanthus maritimus ssp. *maritimus*	Salt marsh bird's-beak	SE	1B	FE
Cordylanthus rigidus ssp.*littoralis*	Seaside bird's-beak	SE	1B	FSC
Dithyrea maritima	Beach spectaclepod	ST	1B	FSC
Eremalche kernensis	Kern mallow		1B	FE
Eriastrum hooveri	Hoover's eriastrum		4	FT
Eriodictyon altissimum	Indian Knob mountainbalm	SE	1B	FE
Eriodictyon capitatum	Lompoc yerba santa	SR	1B	C
Hemizonia increscens ssp. *villosa*	Gaviota tarplant	SE	1B	C
Lasthenia conjugens	Contra Costa goldfields		1B	FPE
Layia carnosa	Beach layia	SE	1B	FE
Lembertia congdonii	San Joaquin woollythreads		1B	FE
Lupinus nipomensis	Nipomo Mesa lupine	SE	1B	C
Pedicularis dudleyi	Dudley's lousewort	SR	1B	FSC
Rorippa gambellii	Gambel's watercress	ST	1B	FE
Sanicula maritima	Adobe sanicle	SR	1B	FSC
Sidalcea hickmanii ssp. *anomala*	Cuesta Pass checkerbloom	SR	1B	FSC
Sidalcea hickmanii ssp. *parishii*	Parish's checkerbloom	SR	1B	C
Suaeda californica	Califomia sea blite		1B	FE
Thermopsis macrophylla	Santa Ynez false-lupine	SR	1B	FSC

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
CNPS: (California Native Plant Society) 1A=presumed extinct in California; 1B=rare,threatened, or endangered in California and elsewhere; 2=rare,threatened,or endangered in California but more common elsewhere; 3=need more information; 4=distribution limited (a watchlist).
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.
Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

Table III-29
Sensitive Fish Species in the Central Coast Region

Scientific Name	Common Name	Status: State	Status: Federal
Eucyclogobius newberryi	Tidewater goby	CSC	FE
Gasterosteus aculeatus williamsoni	Unarmored threespine stickleback	SE	FE
Oncorhynchus mykiss	Steelhead, Southern California ESU	CSC	FE
Oncorhynchus mykiss	Steelhead, South Central California Coast ESU	CSC	FT
Oncorhynchus mykiss	Steelhead, Central California Coast ESU		FT

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

Steelhead runs still exist within San Luis Obispo and Santa Barbara counties, although they have declined from historical levels. In San Luis Obispo County, both San Simeon and Santa Rosa creeks have reduced population levels due to loss of instream habitat. In Chorro Creek, the only spawning habitat is below an impassable dam and is often dewatered during the summer. Arroyo de la Cruz, however, remains fairly pristine and is one of the healthiest steelhead streams in the area.

The Santa Ynez River in Santa Barbara County historically had the largest steelhead runs in southern California. Now the population is almost extirpated due to dams blocking access to most spawning and rearing habitat. This population might possibly be restored if adequate flows are provided. The Santa Ynez River drains the north slope of the Santa Ynez Mountains. Streams draining the south slope also had steelhead runs historically. Resident rainbow trout are still present in most of these streams.

Steelhead, including the Southern California, South Central California Coast, and Central California Coast Evolutionary Significant Units (ESU), were listed under the Endangered Species Act by the National Marine Fisheries Service in August 1997.

8. Wildlife

The Central Coast region contains a wide variety of habitats, from desert scrub to riparian forest, which in turn support diverse animal communities. Because of the overlap between the northern and southern floristic elements, many rare and endangered species inhabit the Central Coastal region. Among the common animal species are mule deer, mountain lion, bobcat, coyote, turkey, hawks, passerines, rodents, snakes, lizards, amphibians, and insects.

Within the riparian areas of the Central Coast, common wildlife species include striped skunks, raccoons, gray fox, pond turtles, various passerines and neotropical migrants, waterfowl, and wading birds. Grasslands contain vernal pool species, as well as species adapted to more arid habitats, like the San Joaquin kit fox, kangaroo rats, and various raptors. The foothill and sycamore woodlands provide habitat for large mammals such as the mountain lion, bobcat, and black-tailed deer, as well as smaller creatures like squirrels, snakes, and quail.

In addition to the common species of the coastal mountains and valleys, the diverse plant communities support 51 sensitive animal species. These include State- or federal-listed species, candidate species, and species of special concern. Of these 51, about half are officially listed as threatened or endangered. Table III-30 lists the sensitive wildlife species found in the Central Coast region.

9. Recreation

The Central Coast Region contains a broad spectrum of recreational opportunities due to its wide variety of habitats. The topography ranges from the interior mountains and valleys to coastal mountains and valleys to the coastal plain. The coastline provides areas for tide-pooling, wildlife watching, hiking, picnicking, swimming, surfing, diving, and fishing, as well as recreational boating and sport fishing on the ocean. The Henry Cowell Redwoods and Pfeiffer Big Sur State Parks are popular recreation areas. Inland, the Los Padres National Forest also provides many recreational opportunities such as hiking, camping, wildlife watching, fishing, and picnicking. Water related recreational opportunities are provided at many of the rivers and reservoirs in the area, including Lake San Antonio, Lake Nacimiento, Lake Cachuma, and Lopez Lake.

J. SOUTHERN CALIFORNIA

The discussion of the environmental setting for Southern California will focus on the areas included in the SWP Contractors' Service Area. This will include the South Coast Region, as described in Bulletin 160-93 (DWR 1994), and will also include the Antelope Valley and Mojave areas of the South Lahontan Region and the Coachella Valley area of the Colorado River Region. Figure III-17 shows the Southern California region.

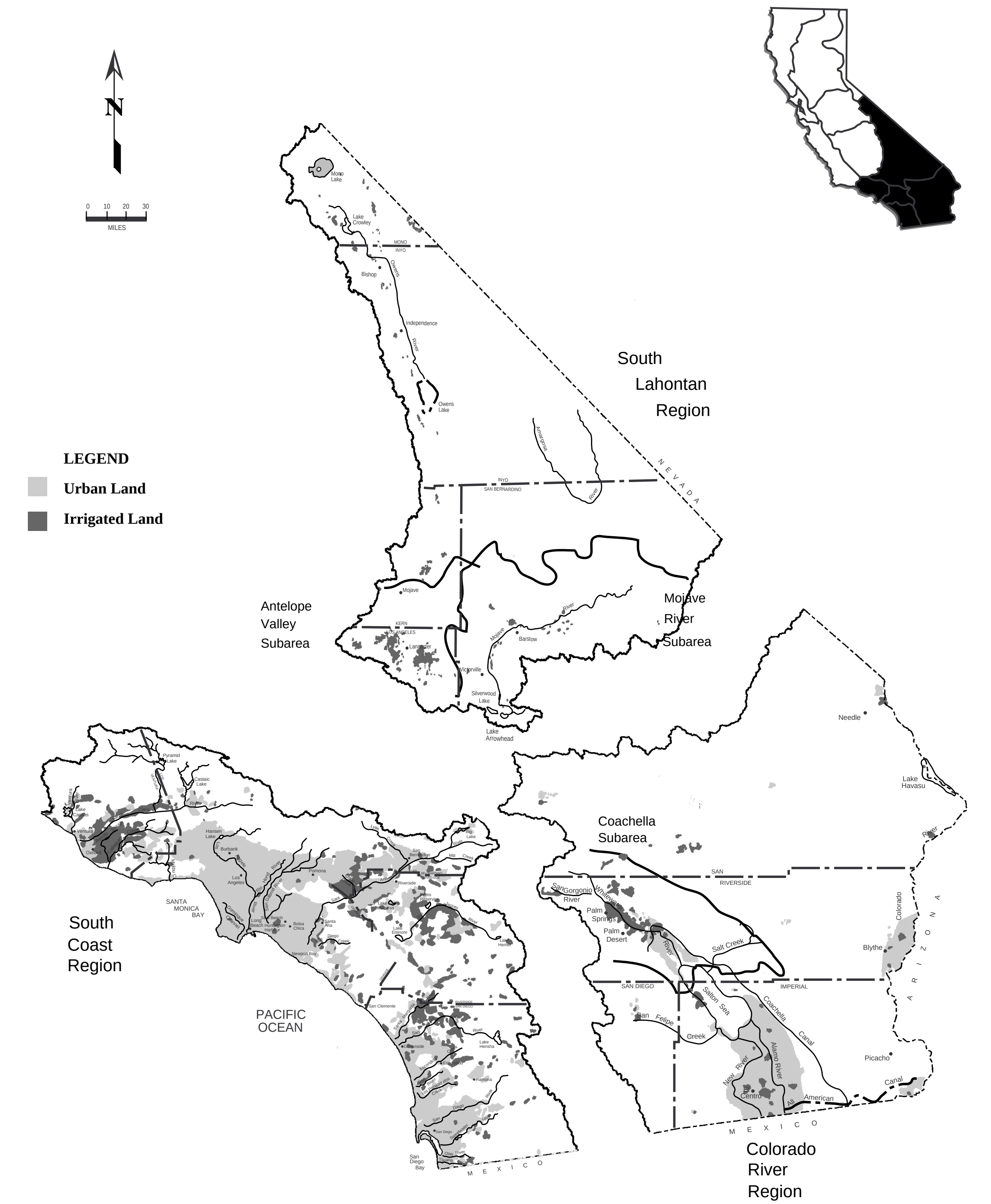
The principal SWP contracting agencies in the Southern California service area include: the Metropolitan Water District of Southern California; Antelope Valley-East Kern, Castaic Lake, Crestline-Lake Arrowhead, Desert, Mojave, and San Gorgonio Pass Water Agencies; Coachella Valley and San Gabriel Valley Municipal Water Districts; and Ventura County Flood Control District. The SWP Southern California service area comprises approximately 10.6 million acres.

Table III-30
Sensitive Wildlife Species in the Central Coast Region

Scientific Name	Common Name	Status: State	Status: Federal
Accipiter cooperi	Cooper's hawk	CSC	
Accipiter striatus	Sharp-shinned hawk	CSC	
Agelaius tricolor	Tricolor blackbird	CSC	FSC
Aquila chrysaetos	Golden eagle	CSC	
Asio flammeus	Short-eared owl	CSC	
Asio otus	Long-eared owl	CSC	
Athene cunicularia	Burrowing owl	CSC	
Brachyramphus marmoratus	Marbled murrelet	SE	FT
Buteo regalis	Ferruginous hawk	CSC	
Buteo swainsoni	Swainson's hawk	ST	
Charadrius alexandrinus nivosus	Western snowy plover	SC FT	
Circus cyaneus	Northern harrier	CSC	
Coccyzus americanus occidentalis	Western yellow-billed cuckoo	SE	
Dendroica petechia brewsteri	Yellow warbler	CSC	
Empidonax traillii	Willow flycatcher	SE	
Falco mexicanus	Prairie falcon	CSC	
Gymnogyps californianus	California condor	SE	FE
Haliaeetus leucocephalus	Bald eagle	SE	FT
Icteria virens	Yellow-breasted chat	CSC	
Ixobrychus exilis hesperis	Western least bittern	CSC	FSC
Laterallus jamaicensis conturniculus	California black rail	ST	FSC
Numenius americanus	Long-billed curlew	CSC	
Pelecanus occidentalis californicus	California brown pelican	SE	FE
Phalacrocorax auritus	Double-crested cormorant	CSC	
Progne subis	Purple martin	CSC	
Rallus longirostris obsoletus	California clapper rail	SE	FE
Riparia riparia	Bank swallow	ST	
Sterna antillarum browni	California least tern	SE	FE
Toxostoma lecontei	Le Conte's thrasher	CSC	
Vireo bellii pusillus	Least Bell's vireo	SE	
Ammospermophilus nelsoni	San Joaquin antelope squirrel	ST	FSC
Dipodomys heermanni morroensis	Morro Bay kangaroo rat	SE	FE
Dipodomys ingens	Giant kangaroo rat	SE	FE
Dipodomys nitratoides brevinasus	Short-nosed kangaroo rat	CSC	
Euderma maculatum	Spotted bat	CSC	FSC
Onychomys torridus tularensis	Tulare grasshopper mouse	CSC	
Plecotus townsendii townsendii	Townsend's western big-eared bat	CSC	
Vulpes macrotis mutica	San Joaquin kit fox	ST	FE
Clemmys marmorata	Western pond turtle	CSC	
Gambelia sila	Blunt-nosed leopard lizard	SE	FE
Phrynosoma coronatum frontale	California horned lizard	CSC	
Ambystoma californiense	California tiger salamander	CSC	C
Bufo microscaphus calfiornicus	Arroyo toad	CSC	FE
Rana aurora draytonii	Calfiornia red-legged frog	CSC	FT
Rana boylii	Foothill yellow-legged frog	CSC	FSC
Branchinecta longiantenna	Longhorn fairy shrimp		FE
Branchinecta lynchi	Vernal pool fairy shrimp		FT
Euphilotes enoptes smithi	Smith's blue butterfly		FE

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.
Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

Figure III-17
Southern California Regions



Source: DWR, Bulletin 160-93 (1994)

1. Geography and Climate

The South Coast Region is the most urbanized region of California. Although it covers only about 7 percent of the State's total land area, it contains over half of the State's population. The region extends east from the Pacific coast and is bounded on the north by the Santa Barbara/Ventura county line and the San Gabriel and San Bernardino mountains, on the south by the Mexican border, and on the east by the San Jacinto Mountains and low-elevation mountain ranges in central San Diego County. The SWP Southern California service area includes Ventura, Los Angeles, and Orange counties, and portions of San Bernardino, Riverside, San Diego, Kern and Imperial counties.

Topographically, the South Coast Region is comprised of a series of broad coastal plains, gently sloping inland valleys, and mountain ranges of moderate elevation. The largest mountain ranges of the region are the San Gabriel, San Bernardino, San Jacinto, Santa Rosa, and Laguna mountains. Peak elevations are generally between 5,000 and 8,000 feet above sea level; however, some peaks are nearly 11,000 feet high. The SWP service area also includes interior deserts in the Antelope, Mojave, and Coachella valleys which are generally east of the South Coast Region. The Coachella Valley is located at the northwest end of the Salton Trough, which extends from San Gorgonio Pass to the Gulf of California. The Salton Sea is situated at the lowest point of the trough and lies below sea level.

The climate of the region is Mediterranean-like, with warm dry summers and mild wet winters. Summer temperatures along the coast are relatively cool as a result of the moderating influence of the ocean. In the warmer interior, summer temperatures are often over 90EF. In the inland deserts, average summer maximum temperatures are 105-110EF. During winter, temperatures seldom drop below freezing except in the mountains and some interior valleys.

Average annual rainfall can range from 10 to 15 inches on the coastal plains and 20 to 45 inches in the mountains. The interior deserts average as little as 4 inches per year. Most of the precipitation falls between December and March. Precipitation in the higher mountains frequently occurs as snow, and in most years, snowfall is sufficient to support winter recreation in the San Gabriel and San Bernardino mountains.

The primary River Basins of the South Coast Region include the Santa Clara, Los Angeles, San Gabriel, Santa Ana, Santa Margarita, and San Luis Rey. Some portions of these rivers have been intensively modified for flood control. The natural runoff of the region's streams and rivers averages about 1.2 million acre-feet per year.

2. Population

The population in the South Coast Region in 1990 was over 16 million, an increase of 26 percent from the 1980 level. Most of the increase is due to immigration, both from within the United States and from around the world. Most of the region's coastal plains are densely populated. The largest cities include Los Angeles, San Diego, Long Beach, Santa Ana, and Anaheim; each is among California's ten most populated cities and Los Angeles and San Diego rank second and sixth largest in the United States, respectively. The region includes six of the ten fastest growing cities with populations between 50,000 and 200,000. They include Corona, Fontana, Tustin, Laguna Niguel, National City, and Rancho Cucamonga. Areas undergoing increased urbanization include the coastal plains of Orange and Ventura counties, the Santa Clarita Valley in northwestern Los Angeles County, the Pomona/San Bernardino/Moreno valleys, and the valleys north and east of the City of San Diego. The population of this region is expected to increase by 55 percent by 2020.

The desert regions contain some of the fastest growing urban areas in California, including the cities of Lancaster and Palmdale in the Antelope Valley of Los Angeles County and the Victor and Apple valleys of San Bernardino County. Many new resident in these valleys commute to the greater Los Angeles area to work. Major local employment includes the aerospace industry of Palmdale Airport and Edwards Air Force Base. The combined population in the Mojave and Antelope valleys in 1990 was about 525,000. Major cities in the Coachella Valley include Palm Springs, Indio, Cathedral City, and Palm Desert. The 1990 population for the Coachella Valley was 263,000.

3. Land Use

Since the 1940's, Southern California has changed from a largely rural community with an agricultural economy to a highly urban-industrial society. Despite being so urbanized, about one-third of the South Coast Region's land is publicly owned. Of the approximately 2.3 million acres of public land, about 75 percent is national forest. Urban land use accounts for about 1.7 million acres and irrigated cropland accounts for less than 300,000 acres.

The major industries in the region are national defense, aerospace, recreation and tourism, and agriculture. Other large industries include electronics, motion picture and television production, oil refining, housing construction, government, food and beverage distribution, and manufacturing (clothing and furniture). While defense, aerospace, and oil refining are in decline, the South Coast Region has a strong and growing commercial services sector. International trading, financing, and basic services are major economic contributors to the region.

In the coastal areas of Southern California, agriculture remains important economically, despite urbanization. Farms generally produce high value crops on small irrigated parcels. The largest amount of irrigated agriculture is in Ventura County, where 116,600 acres of cropland is devoted primarily to fresh market vegetables, strawberries, and citrus and avocados. The San Diego area has more than 110,000 acres in irrigated agriculture, most of which is planted in citrus and avocados. Fresh market vegetables are grown throughout the regions coastal and inland valleys which are also ideally suited for growing other high-value crops such as nursery products and cut flowers. Other irrigated agriculture includes forage and field crops related to the dairy industry and vineyards.

Agriculture is also important in the Colorado Desert, especially in the Coachella and Imperial valleys, where livestock, field crops, truck crops, grain, sugar beets, and cotton are produced. There were 74,000 irrigated acres in the Coachella Valley in 1990. Poultry, livestock, and field crops are produced in the Mojave Desert. Alfalfa and pasture are the principal crops grown on approximately 26,000 acres of irrigated agricultural lands in the Antelope and Mojave basins. Almond, apple, apricot, pear, grain, and some truck crops are also grown.

Recreation and tourism together have become the second most important industry in the Coachella Valley. Developers have constructed world-class hotels, country clubs, golf courses, and residential communities. Over 90 golf courses have been established in the valley, contributing to the influx of retirees and vacationers from around the world.

4. Water Supply

Because local water supplies are limited, imported water has played a significant role in meeting the area's growing water demands. Since the turn of the century, water development has been carried out on a massive scale throughout Southern California. Steady expansion of the population and economy lead to sufficient demand and financial backing to build large water supply projects for importing water into the region. Due to the highly seasonal precipitation, the major rivers in the service area do not provide a substantial or reliable surface water supply. The runoff in the intermittent streams that flow from the mountains primarily percolates into groundwater basins. Most of the local water sources have been developed to provide flood control, groundwater recharge, and water supply. About two thirds of the South Coast Region's 1990 water supply comes from surface water imports. The remaining portion is supplied by groundwater (25 percent), local surface water (6 percent), and reclaimed water (2 percent).

Water is imported into Southern California from three sources: (1) the Owens Valley and Mono Lake Basin; (2) the Colorado River; and (3) the SWP. The City of Los Angeles first brought imported water into the area from Owens Valley via the Los Angeles Aqueduct in 1913. With the addition of a second conduit in 1970, the Mono-Owens supply is about 10 percent of the region's 1990 level water supply. As development on the coastal plain increased, the Colorado River was tapped as a second imported supply by the Metropolitan Water District of Southern California (MWD), which constructed the Colorado River Aqueduct in 1941. The Colorado River provides about 29 percent of the 1990 level water supply. Both of these import facilities have been operating at or near capacity. A third major source of imported water, the SWP, first made deliveries from the Sacramento-San Joaquin Delta to the Southern California area through the California Aqueduct in 1972, and today furnishes about 28 percent of the region's supply. SWP service contractors in Southern California have entitlement to 2.5 million acre-feet, which is 59 percent of the ultimate minimum yield of the project; however, not all of the SWP contractors receive their full entitlement at this time.

Three significant events have occurred subsequent to 1990 which will likely reduce imports to the region via the Los Angeles Aqueduct by a significant amount. These events include: (1) adoption by the SWRCB of Water Right Decision 1631, which substantially reduced the water available for export from the Mono Basin; (2) approval by the City of Los Angeles and the County of Inyo of the Inyo-Los Angeles Agreement, which will substantially reduce the quantity of groundwater that can be exported from the Owens Valley; and (3) adoption by the Great Basin Unified Air Pollution Control District of a state implementation plan, which provides for the release of water by the City of Los Angeles onto the historically dry Owens Lake bed to control the emission of PM10. Together, it is anticipated that these events will reduce the quantity of water imported into the region via the Los Angeles Aqueduct by up to 120,000 acre-feet per year, which is in excess of 25% of historical diversions of the Los Angeles Department of Water and Power.

Groundwater supplies a significant portion of the water in the Southern California service area. Although further development is possible in a few local areas, some of the basins have been over-used, and as a result, have been adjudicated or managed by public agencies.

In 1990, the Coachella Valley used 85,000 acre-feet of groundwater, 52,000 of which was considered overdraft. MWD has an exchange agreement with Desert Water Agency and Coachella Valley Water District that allows MWD to take the two agencies' SWP entitlement water. In return, MWD releases water from its Colorado River Aqueduct for groundwater recharge in the Coachella Valley.

Groundwater is the major, if not only, local source of water in the Mojave and Antelope valleys. Problems associated with overdraft have resulted in adjudication of the Mojave groundwater basin and sporadic efforts to either adjudicate or develop groundwater management plans for the Antelope Valley basin. These efforts could restrict the use of groundwater and give impetus to developing more active conjunctive use programs. Such programs would have to rely on imported water supplies to a considerable extent.

In the heavily urbanized Coastal Plain area extending into Ventura County and eastward into San Bernardino and Riverside counties, reliance on groundwater is less because more surface water is available. However, annual groundwater extractions exceed 1.5 million acre-feet, which is a much larger absolute use but a smaller proportion of the overall water supply. Annual overdraft has been estimated to be as high as 200,000 acre-feet. A long history of largely uncontrolled groundwater use in this area resulted in serious over-exploitation of many basins, with resultant seawater intrusion and declining water levels. As a result of litigation springing from these problems, most of the major groundwater basins have been adjudicated or have had active groundwater management programs developed. In the adjudicated basins, the rights to pump groundwater have been quantified and assigned. In these basins, the annual amount of water that can be pumped is controlled, and pumping in excess of an adjudicated rate generally requires procurement of an offsetting replenishment supply. The nature of the adjudication process makes it somewhat difficult to modify basin operation significantly to alleviate short-term water shortages, particularly under drought conditions. Managed basins often have similar restrictions but tend to be more flexible in their ability to respond to changing conditions.

Urban areas overlying much of the groundwater basins continue to expand, resulting in loss of recharge capability. This loss has been partially offset by development of extensive artificial recharge programs. Nevertheless, the limited opportunities for recharge will necessitate prudent use of groundwater as a source of supply during extended dry periods.

In San Diego County, groundwater basins tend to be much smaller. Although they constitute an important part of the water supply system, these basins have little potential for more use in the short term.

a. Surface Water Hydrology. Many streams flow down the southwestern slope of the Transverse Ranges and the western slope of the Peninsular Ranges to drain into the Pacific Ocean. These include the Santa Clara, Ventura, Los Angeles, San Gabriel, Santa Ana, San Jacinto, San Diego, San Luis Rey, Santa Margarita, Otay, and Tijuana rivers. Dams and reservoirs regulate many of these rivers. Large reservoirs in the area, most of which are storage facilities for imported supplies, include Pyramid Lake, Castaic Lake, Silverwood Lake, Lake Perris, Lake Casitas, Lake Mathews, El Capitan Reservoir, San Vicente and Lake Havasu. Table III-31 lists the major reservoirs in the Southern California Region.

On the eastern side of the Peninsular Ranges lie the Mojave and Colorado deserts. Streams there typically have intermittent flow and, with the exception of the Colorado River, primarily drain into groundwater basins or interior lakes. Rainfall in the desert is scarce and highly seasonal but at times is so intense that watercourses overflow and cover large areas with sheet flow. These conditions result in changing patterns of erosion and deposition. Desert rivers include the Mojave, Colorado, San Gorgonio, Alamo, and New rivers. Lakes and reservoirs are scarce in this area, with the exception of dry lakebeds and the Salton Sea.

b. Surface Water Quality. Southern California has many water quality problems. Along the coast, thermal discharges from electrical generation plants and nutrient overloading of streams cause local problems. In the desert, the problems are more general and relate to increasing salinity of groundwater and lakes such as the Salton Sea.

Along the coast, water quality in streams, lakes, and reservoirs varies from good (water that supports and enhances the designated beneficial uses) to intermediate (water that supports designated beneficial uses but with occasional degradation of water quality) to impaired (water that cannot reasonably be expected to attain or maintain applicable water quality standards).

The Santa Clara River contains 79 river miles of intermediate quality water due to pollutants in urban and agricultural runoff. The upper Ventura River consists of 9 miles of good quality water; the lower river has 6 miles of impaired quality from high ammonia levels and low dissolved oxygen. The Los Angeles River varies from intermediate to impaired water quality due to urban runoff, high ammonia levels, and high volatile organic compounds. The Santa Ana River varies from good to impaired, with impaired reaches exhibiting toxic bioassay results and threats to recreational and

Table III-31
Major Reservoirs in the Southern California Region

Reservoir	River	Capacity (TAF)	Owner
Casitas	Coyote Creek	254	USBR
Lake Piru	Piru Creek	88	United WCD
Pyramid	Piru Creek	171	DWR
Castaic	Castaic Creek	324	DWR
San Gabriel	San Gabriel	42	LACFCD/DWP
Big Bear Lake	Bear Creek	73	Big Bear MWD
Perris	Bernasconi Pass	132	DWR
Mathews	Trib Cajalco Creek	179	MWDSC
Irvine Lake	Santiago Creek	25	Serrano ID/Irvine Ranch
Skinner	Tucalota Creek	44	MWDSC
Vail	Temecula Creek	50	Rancho Calif. WD
Henshaw	San Luis Rey River	53	Vista ID
Lake Hodges	San Dieguito River	38	City of San Diego
Sutherland	Santa Ysabel Creek	29	City of San Diego
San Vincente	San Vincente Creek	90	City of San Diego
El Capitan	San Diego River	113	City of San Diego
Lower Otay	Otay River	50	City of San Diego
Morena	Cottonwood Creek	50	City of San Diego
Barrett	Cottonwood Creek	38	City of San Diego
Seven Oaks	Santa Ana River	146	USCOE (under const.)
Prado	Santa Ana River	183	USCOE
Silverwood	West Fork Mojave	75	DWR

Source: DWR 1993b

groundwater uses. The San Jacinto River has good water quality, the San Diego River has intermediate, and San Diego Creek suffers from impaired water quality. Elevated levels of toxins have been found in the tissues of fish and shellfish in San Diego Creek, as well as eutrophication problems. As with many rivers that cross the international border, the Tijuana River has impaired water quality due to untreated wastewater.

Many of the reservoirs along the west slope of the Peninsular Ranges contain water of good quality. However, Big Bear Lake is facing both eutrophication and sedimentation problems, as well as increasing levels of toxins in fish tissues; and Perris Reservoir contains potential precursors of trihalomethanes. Intermediate quality water can be found in Lake Hodges and in Casitas Lake, which suffers from turbidity problems.

Rivers within the Colorado and Mojave deserts, for the most part, have poor water quality. The Alamo River has impaired quality water, which is evident in the increasing levels of toxins in fish tissue and the threat of toxic bioassay results. The New River also contains water of impaired quality and has been declared a public health hazard. San Gorgonio River water quality is unknown. The Mojave River varies from good to impaired, with problems caused by sedimentation and toxic pollutants. The portion of the Colorado River that runs along the eastern boundary of California contains water considered to be of good quality.

Lakes and reservoirs in the desert seem to contain either good or impaired quality water, although even areas with good quality are threatened. Lake Silverwood is considered good quality water, although there is the potential for mercury problems. Lake Havasu is also considered good, but there is a threat of increasing levels of selenium in fish tissue. The Salton Sea contains water of impaired quality demonstrated by high salinity levels and high levels of selenium in fish tissues.

The water delivered to the City of Los Angeles via the LA Aqueduct generally has less than 230 mg/L total dissolved solids. Other water imported into Southern California ranges from less than 220 mg/L for SWP supplies to 750 mg/L for Colorado River water. In some areas, SWP water is blended with Colorado River water to provide a larger supply of water with acceptable TDS levels.

c. **Groundwater Hydrology**. The South Coastal Region has at least 44 major groundwater basins. Groundwater commonly occurs in alluvial basins that vary greatly in size and storage capacity. Typically, the basins contain a complex interfingering of coarse-grained aquifer and fine-grained material that limits water movement between aquifers. Many basins contain fine-grained material at or near the surface, which limits the area through which groundwater recharge can be accomplished. The relatively low recharge rates in comparison to storage capacity in many basins have resulted in a tendency toward over-exploitation.

The most significant groundwater basins in the interior desert portions of the service area include the Antelope, Mojave, and Coachella valleys. Urban areas are expanding in all three valleys, and supplemental water from the SWP is available to them. Nevertheless, annual groundwater extraction from these areas is about 433,000 acre-feet, with a resultant overdraft of as much as 221,000 acre-feet.

Potential adverse impacts of continued overdraft include land subsidence, increased pumping costs, and water quality degradation. In the 1970s, the Antelope Valley-East Kern Water Agency began receiving deliveries of SWP water and recharging the groundwater basin. Groundwater levels in some portions of the basin have risen 40 feet or more since the introduction of SWP water.

Seawater intrusion can be a significant water quality problem in coastal groundwater basins. Historically, seawater has intruded into most coastal basins in this area. Injection wells are used to create intrusion barriers along the coast in Orange and Los Angeles counties. The barriers use imported surface water and reclaimed waste water for injection and increase the extent to which inland groundwater levels can be drawn down. However, the barriers are not entirely effective (or even present in some basins), thus limiting the availability of groundwater for use during extended dry periods.

d. **Groundwater Quality**. Although much of the groundwater in Southern California is suitable for municipal and agricultural supplies, substantial degradation in some areas, such as San Diego County, limits groundwater use. Loss of production capability, while of concern, has been relatively small. Given the heavily urban character of the area and the former widespread citrus orchards, elevated levels of nitrate and total dissolved solids, as well as contamination by synthetic organics, are a fairly common problem in some basins. In particular, the San Fernando and San Gabriel basins have widespread synthetic organics contamination, which constrains basin operations in order to limit the spread of contamination. Similar but less severe limitations on operations exist in many other basins.

The groundwater within most basins of the south coastal area is suitable for all beneficial uses. Groundwater temperature and total dissolved solids content tends to vary considerably between basins. In basins where Colorado River water is being used for recharge, the groundwater has begun to take on qualities of the recharge water and is inferior to the natural groundwater. Hardness is a common water quality problem in many basins. Almost all of the basins are highly developed except in San Diego County, where the basins are not as extensive and, in some cases, contain water of inferior quality not suitable for domestic use. Sea water intrusion is known to be occurring or has the potential to occur in several south coastal basins, including the Coastal Plain of Los Angeles, the Coastal Plain of Orange County, Santa Margarita Valley, San Luis Rey Valley, San Dieguito Valley, and Mission Valley.

Groundwater quality in the Mojave River area is fair. Total dissolved solids concentrations range from about 300 to 1000 mg/L and are predominantly calcium or sodium bicarbonate in character, with calcium predominating in the recharge area of the foothills and sodium in the middle and lower discharge areas of the playas. Groundwater quality in the immediate vicinity of the California Aqueduct in Antelope Valley is excellent. Total dissolved solids concentrations of about 150 to 300 mg/L dominate, with a few smaller areas around the communities of Littlerock and Pearblossom having concentrations of about 300 to 500 mg/L. The predominant character of the water in the Coachella Valley is sodium sulfate or sodium chloride, but significant quantities of calcium and bicarbonate are also present in some locations. Groundwater temperature ranges from about 60° to about 90°F; however, a temperature in excess of 200°F has been recorded. Total dissolved solids content of the water varies considerably, but is generally less than 600 mg/L.

5. Water Use

The total net water demand for the South Coast Region in 1990 was nearly 4.4 million acre-feet. Urban use accounted for 80 percent of the net water demand, while agricultural use was 15 percent of the total. Urban water demand for the South Coast Region has rapidly increased due to tremendous growth rates and expanding urbanized areas. In many areas, urban expansion has led to reductions in agricultural acreage and water use.

The total net water demand for the Antelope Valley and Mojave River areas in 1990 was about 225,000 acre-feet, and was nearly equally split between urban and agricultural use. Net urban demand in the Coachella Valley was 165,000 acre-feet, and net agricultural demand was 313,000 acre-feet. Net water demand in the Coachella Valley is expected to increase slightly by 2020, but the ratio of urban-to-agricultural use is expected to reverse with urban use more than doubling and agricultural use falling by nearly half.

6. Vegetation

While some of the naturally occurring vegetation in the Southern California service area has been altered significantly by urban and agricultural development, a large part of the region, mostly uplands, retains it native cover. The dominant natural vegetation type in the non-urbanized portion of the South Coast Region is a mixture of coastal sage scrub and chaparral communities, covering nearly half of the land area. The other vegetation communities include grassland, freshwater emergent wetland, saline emergent wetland, coastal scrub, coastal dunes, desert scrub, desert dunes, woodland, forest, and agricultural/urban. Numerous sensitive plant species occur in those communities. Table III-32 lists the sensitive plant species found in the Southern California region.

Chaparral, the most abundant plant community in the Southern California area, represents the typical vegetation. Chaparral is composed of various species of manzanita, wild lilac, ceanothus, oak, sage, mountain mahogany, and chamise. This community is often found on hot, dry slopes, ridges, and mesas and on poor soils that are shallow, sandy, and have low water-holding capacity. While chaparral has little commercial value, it provides valuable wildlife habitat and forms a protective cover to prevent erosion in steep watersheds. Two types of sensitive chaparral habitat, southern maritime chaparral and southern mixed chaparral, occur in Southern California.

Coastal sage scrub, once abundant, is now disappearing because of urban development. Inland sage is usually found on dry slopes below 3,000 feet on the coastal side of mountains. Other scrub communities include the creosote brush scrub (found on the floor of the Mojave Desert and along its lower slopes) and succulent scrub (found in scattered locations throughout the southern desert) communities. Sensitive coastal scrub habitats in Southern California include southern coastal bluff scrub, maritime succulent scrub, Diegan coastal sage scrub, and Riversidean sage scrub.

Agriculture and urban uses have largely displaced the native grasslands of the Southern California service area. With few exceptions, the remaining grasslands consist of introduced annual grasses and forbs. Sensitive grassland habitats in Southern California include valley needlegrass grassland, serpentine bunchgrass, wildflower fields, southern interior basalt flow vernal pool, San Diego mesa hardpan vernal pool, San Diego mesa claypan vernal pool, alkali seep, freshwater seep, alkali playa, and pavement plain.

Coastal strand plants and coastal salt- and fresh-water marshes, once common along the coastline in Southern California, have almost disappeared due to filling and dredging to create seaside developments, marinas, and ports. Remnants of these communities have been set aside in public and private preserves. Sensitive freshwater wetland habitats in Southern California include coastal and valley freshwater marsh, cismontane alkali marsh, and transmontane alkali marsh. Sensitive saline wetland habitats in Southern California are the southern coastal salt marsh and coastal brackish marsh. Two types of sensitive coastal dune habitat in Southern California are southern foredunes and southern dune scrub.

Table III-32
Sensitive Plant Species in the Southern California Region

Scientific Name	Common Name	Status State	Status CNPS	Status Federal
Acanthomintha ilicifolia	San Diego thorn mint	SE	1B	FPE
Allium munzii	Munz's onion	ST	1B	FPE
Arabis johnstonii	Johnston's rock cress		1B	FTP
Arctostaphylos glandulosa ssp. *crassifolia*	Del Mar manzanita		1B	FE
Arenaria paludicola	Marsh sandwort	SE	1B	FE
Arenaria ursina	Bear Valley sandwort		1B	FPT
Astragalus albens	Cushenbury milk-vetch		1B	FE
Astragalus brautonii	Braunton's milk-vetch		1B	FE
Astragalus jaegerianus	Lane Mountain milk-vetch		1B	FPE
Astragalus lentiginosus var. *coachellae*	Coachella Valley milk-vetch		1B	FPE
Astragalus magdalenae var. *perisonii*	Peirson's milk-vetch	SE	1B	FPE
Astragalus tener var. *titi*	Coastal dunes milk-vetch	SE	1B	FPE
Astragalus tricarinatus	Triple-ribbed milk-vetch		1B	FPE
Atriplex coronata var. *notatior*	San Jacinto Valley crownscale		1B	FPE
Baccharis vanessae	Encinitas baccharis	SE	1B	FT
Berberis nevinii	Nevin's barberry	SE	1B	FPE
Brodiaea filifolia	Thread-leaved brodiaea	SE	1B	FPT
Calochortus dunnii	Dunn's mariposa lily	SR	1B	FSC
Castilleja cinerea	Ash-gray Indian paintbrush		1B	FPT
Castilleja gleasonii	Mt. Gleason Indian paintbrush	SR	1B	FSC
Ceanothus ophiochilus	Vail Lake ceanothus	SE	1B	FPT
Chorizanthe orcuttiana	Orcutt's spineflower	SE	1B	FE
Cordylanthus maritimus ssp. *maritimus*	Salt marsh bird's-beak	SE	1B	FE
Corethrogyne filaginifolia var. *linofolia*	Del Mar Mesa sand aster		1B	FSC
Croton wigginsii	Wiggin's croton	SR	2	
Delphinium hesperium ssp. *cuyamacae*	Cuyamaca larkspur	SR	1B	FSC
Dithyrea maritima	Beach spectaclepod	ST	1B	FSC
Dodecahema leptoceras	Slender-horned spineflower	SE	1B	FE
Downingia concolor var. *brevior*	Cuyamaca Lake downingia	SE	1B	FSC
Dudleya abramsii ssp. *parva*	Conejo dudleya		1B	FT
Dudleya blochmaniae ssp. *brevifolia*	Short-leaved dudleya	SE	1B	C1
Dudleya cymosa ssp. *marcescens*	Marcescent dudleya	SR	1B	FT
Dudleya cymosa ssp. *ovatifolia*	Santa Monica Mountains dudleya		1B	FT
Dudleya densiflora	San Gabriel Mountains dudleya		1B	C
Dudleya stolonifera	Laguna Beach dudleya	ST	1B	FPE
Dudleya verityi	Verityi's dudleya		1B	FT
Eriastrum densifolium ssp. *sanctorum*	Santa Ana River woollystar	SE	1B	FE
Erigeron parishii	Parish's daisy		1B	FT
Eriogonum crocatum	Conejo buckwheat	SR	1B	FSC
Eriogonum ericifolium var. *thornei*	Thorne's buckwheat	SE	1B	FSC
Eriogonum kennedyi var. *austromontanum*	Southern mountain buckwheat		1B	FPT
Eriogonum ovalifolium var. *vineum*	Cushenbury buckwheat		1B	FE
Eryngium aristulatum var. *parishii*	San Diego button-celery	SE	1B	FE
Fremontodendron mexicanum	Mexican flannelbush	SR	1B	FPE
Galium angustifolium ssp. *borregoense*	Borrego bedstraw	SR	1B	FSC
Helianthus niveus ssp. *tephrodes*	Algodones Dunes sunflower	SE	1B	FSC

Table III-32 (cont.)
Sensitive Plant Species in the Southern California Region

Scientific Name	Common Name	Status: State	Status: CNPS	Status: Federal
Helianthus nuttallii ssp. *parishii*	Los Angeles sunflower		1A	FSC
Hemizonia conjugens	Otay tarplant	SE	1B	FPE
Hemizonia minthornii	Santa Susana tarplant	SR	1B	FSC
Hemizonia mohavensis	Mohave tarplant	SE	1A	FSC
Ivesia callida	Tahquitz ivesia	SR	1B	FSC
Lesquerella kingii ssp. *bernardina*	San Bernardino Mtn. bladderpod		1B	FE
Limnanthes gracilis ssp. *parishii*	Parish's meadowfoam	SE	1B	FSC
Machaeranthera asteroides var. *lagunensis*	Laguna Mountains aster	SR	2	FSC
Monardella linoides ssp. *viminea*	Willowy monardella	SE	1B	FPE
Navarretia fossalis	Prostrate navarretia		1B	FPT
Nolina interrata	Dehesa nolina	SE	1B	FPT
Orcuttia californica	California Orcutt grass	SE	1B	FE
Oxytheca parishii var. *goodmaniana*	Cushenbury oxytheca		1B	FE
Pentachaeta lyonii	Lyon's pentachaeta	SE	1B	FE
Poa atropupurea	San Bernardino bluegrass		1B	FPE
Pogogyne abramsii	San Diego Mesa mint	SE	1B	FE
Pogogyne nudiuscula	Otay Mesa mint	SE	1B	FE
Puccinellia parishii	Parish's alkali grass		1B	FPE
Rorippa gambellii	Gambel's watercress	ST	1B	FE
Rosa minutifolia	Small-leaved rose	SE	2	FSC
Senecio ganderi	Gander's ragwort	SR	1B	FSC
Sidalcea hickmanii ssp. *parishii*	Parish's checkerbloom	SR	1B	C
Sidalcea pedata	Bird-footed checkerbloom	SE	1B	FE
Taraxacum californicum	California dandelion		1B	FPE
Trichostema austromontanum compactum	Hidden Lake bluecurls		1B	FPT
Verbesina dissita	Crown beard	ST	1B	FT

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.

CNPS: (California Native Plant Society) 1A=presumed extinct in California; 1B=rare,threatened, or endangered in California and elsewhere; 2=rare,threatened,or endangered in California but more common elsewhere; 3=need more information; 4=distribution limited (a watchlist).

FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

Desert dune habitat, found throughout the Mojave and Sonoran deserts, varies from barren sand expanses to partial cover by shrubs and herbaceous plants to nearly complete shrub canopy closure. Desert dunes are usually found between sea level and 5,000 feet in elevation. Sensitive dune habitats in Southern California include active desert dunes, stabilized and partially stabilized desert dunes, and stabilized and partially stabilized desert sand fields.

Desert scrub is found throughout the Mojave and Sonoran deserts and is the most widespread desert vegetation community type. Many species are found in this habitat, including creosote bush, agave, barrel cactus, teddybear cholla, rabbitbrush, and yucca. In addition to the creosote brush scrub and the pinyon-juniper and Joshua tree woodlands, alkali communities are found in the desert areas where drainage is poor.

The woodland communities include the foothill, pinyon-juniper, and Joshua tree woodlands. The foothill woodlands (primarily southern oaks) serve as a transition zone between the grasslands and forest communities. The oak woodland communities continue to be threatened by urbanization and are impacted by firewood harvesting. Pinyon-juniper woodlands are found in the higher elevations of the Mojave Desert and Joshua tree woodlands are found in the lower elevations of the high desert. Sensitive foothill woodland communities in Southern California include valley oak woodland, open Englemann oak woodland, dense Englemann oak woodland, and California walnut woodland. Sensitive desert woodland communities include Joshua tree woodland, crucifixion thorn woodland, all-thorn woodland, and Arizona woodland.

The forest community occurring in Southern California is montane coniferous forest. This community is usually found in the higher elevations (above 5,000 feet) of the Transverse Range (Santa Ynez, Santa Monica, Santa Suzana, San Gabriel, and San Bernardino mountains) and the Peninsular Ranges (Santa Ana, San Jacinto, Santa Rosa, Palomar, Cuyamaca, and Laguna mountains). The majority of the forests in this area occur on U.S. Forest Service lands.

Stream channels pass through all of the above communities, but most are seasonal and carry water only during rainfall events or during spring. Many of these channels support riparian communities and contain vegetation that provides habitat for wildlife and migration or travel corridors to and from surrounding habitats. In many areas, large trees and shrubs are found only in and along stream courses and dry washes.

7. Fish

Many of Southern California's waterways have been heavily altered by human activities. The fish fauna of the area also has been significantly altered.

Southern California has a variety of different aquatic habitats which support a variety of fish species. Coldwater rivers along the coast support steelhead, trout, speckled dace, and suckers. Trout are available in many of the higher elevation lakes and streams and warm-water gamefish are found in most of the lakes throughout the area. The Colorado River, a warmwater river, has populations of catfish, suckers, squawfish, rainbow trout (in the colder tributaries), and red shiner. Aqueducts and reservoirs contain resident and stocked fish, including largemouth bass, smallmouth bass, striped bass, crappie, threadfin shad, tule perch, channel catfish, green sunfish, bluegill, and trout. The desert springs and streams support tui chub and pupfish.

There are two races of steelhead: winter steelhead and summer steelhead. Only winter steelhead occur naturally along the Southern California coast. Their historical range included streams as far south as the Tijuana River; however, the most extensive population declines and extinctions have occurred at this southern extent of their range. Other sensitive fish species are listed in Table III-33.

Table III-33
Sensitive Fish Species in the Southern California Region

Scientific Name	Common Name	Status State	Status Federal
Catostomus santaanae	Santa Ana sucker	CSC	FSC
Cyprinodon macularius	Desert pupfish	SE	FE
Cyprinodon nevadensis amargosae	Amargosa pupfish	CSC	
Cyprinodon nevadensis nevadensis	Saratoga Springs pupfish	CSC	
Eucyclogobius newberryi	Tidewater goby	CSC	FE
Gasterosteua aculeatus williamsoni	Unarmored threespine stickleback.	SE	FE
Gila bicolor mohavensis	Mojave tui chub	SE	FE
Ptychocheilus lucius	Colorado squawfish	SE	FE
Rhinichthys osculus ssp.1	Amargosa Canyon speckled dace	CSC	FSC
Rhinichthys osculus ssp.3	Santa Ana speckled dace	CSC	FSC
Xyrauchen texanus	Razorback sucker	SE	FE

STATE: SE=endangered; ST=threatened; SR=rare; SC=candidate for listing; CSC=special concern.
FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

8. Wildlife

The Southern California area supports a great diversity of wildlife. The coastal strand community functions as an important breeding and rearing ground for numerous shorebirds including plovers, turnstones, sandpipers, and gulls. Marshes provide important habitat for migratory waterfowl, clapper rails, loons, and pelicans, amphibians, and western pond turtles (in fresh water). Lakes and reservoirs in Southern California provide habitat for numerous geese, ducks, and shorebirds.

The dominant animal in the chaparral community is the mule deer. Other common mammals in this habitat include coyotes, bobcats, foxes, woodrats, and skunks. Resident birds include thrashers, wrentits, bushtits, and jays. Migratory birds such as sparrows, warblers, and robins also use this habitat. Reptiles are abundant throughout this community, and amphibians occur in locations where moisture is continuously present.

While the scrub community may appear sparse, it supports many resident species including towhees, sparrows, wrens, and quail. Mammals supported by this habitat include coyotes, foxes, skunks, and mice. Creosote brush scrub is especially good habitat for numerous species of lizards and snakes.

The grassland community provides habitat for several species of mice, ground squirrels, and rabbits. Coyotes are the most abundant carnivores and this community supports several species of birds, including predators such as owls, hawks, and eagles, and seed-eating birds such as sparrows, doves, and quail.

The foothill woodland community provides roosting and nesting sites for raptors such as hawks and eagles. Several kinds of woodpeckers are commonly found in this habitat. The pinyon-juniper woodland community supports species that are found in both the desert and coniferous forest communities, including jays, warblers, and orioles.

The coniferous forest community supports several species of birds, including woodpeckers, nuthatches, and creepers. Dominant mammals include deer, coyotes, and mountain lions. California kingsnakes, lodgepole chipmunks, and porcupines are found only in this type of habitat.

The diversity of habitats available in the area, combined with the impacts of a rapidly developing human population, has resulted in a large number of rare and endangered species. Steps have been taken to preserve habitats that have unique biological significance. One endangered fish, the unarmored three-spine stickleback, exists in the service area but is no longer found in the Los Angeles, San Gabriel, and Santa Ana rivers. Increased recreational use and development threaten the population in the Santa Clara River. Other sensitive wildlife species are listed in Table III-34.

9. Recreation

Southern California contains a broad spectrum of recreational opportunities due to its wide variety of habitats. The topography ranges from the coastal plain to the interior mountains and valleys to the desert. Along the coastlines, beaches provide areas for tide-pooling, wildlife watching, hiking, picnicking, swimming, surfing, diving, and fishing.

Recreational boating and sportfishing on the ocean are also popular. Inland, national forests provide areas for hiking, camping, wildlife watching, fishing, picnicking, and other activities. Rivers and reservoirs in the area also provide for water-oriented recreation. The desert areas are used for hiking, wildlife watching, camping, and off-road vehicles.

The four SWP reservoirs and other lakes and reservoirs in Southern California receive heavy year-round recreational use. Castaic Lake provides as many as a million visitor-days per year, and Lake Perris receives more than 800,000. Boating, swimming, fishing, water-skiing, picnicking, camping, hiking, hunting, scuba diving, and rock climbing are available in and around the lakes and reservoirs.

Recreation facilities along the California Aqueduct include a bicycle trail that extends 105 miles from Quail Lake near Interstate Highway 5 to a point near Silverwood Lake in San Bernardino National Forest. The U.S. Forest Service plans to route a portion of the Pacific Crest National Scenic Trail along the California Aqueduct, establishing a hiking and equestrian route. Five fishing access sites are also available along the East Branch of the aqueduct.

Table III-34
Sensitive Wildlife Species in the Southern California Region

Scientific Name	Common Name	Status State	Status Federal
Accipiter cooperi	Cooper's hawk	CSC	
Accipiter striatus	Sharp-shinned hawk	CSC	
Agelaius tricolor	Tricolored blackbird	CSC	FSC
Aquila chrysaetos	Golden eagle	CSC	
Asio Flammeus	Short-eared owl	CSC	
Asio otus	Long-eared owl	CSC	
Athene cunicularia	Burrowing owl	CSC	
Brachyramphus marmoratus marmoratus	Marbled murrelet	SE	FT
Charadrius alexandrinus nivosus (Pacific Coast)	Western snowy plover	CSC	FT
Circus cyaneus	Northern harrier	CSC	
Coccyzus americanus occidentalis	Western yellow-billed cuckoo	SE	
Colaptes auratus chrysoides	Gilded northern flicker	SE	
Cypseloides niger	Black swift	CSC	
Dendroica petechia brewsteri	Yellow warbler	CSC	
Dendroica petechia sonorana	Sonoran yellow warbler	CSC	
Empidonax traillii	Willow flycatcher	SE	
Empidonax traillii extimus	Southwestern willow flycatcher		
Falco mexicanus	Prairie falcon	CSC	
Falco peregrinus anatum	American peregrine falcon	SE	FE
Gymnogyps californianus	California condor	SE	SE
Haliaeetus leucocephalus	Bald eagle	SE	FT
Icteria virens	Yellow-breasted chat	CSC	
Laterallus jamaicensis coturniculus	California black rail	ST	FSC
Melanerpes uropygiallis	Gila woodpecker	SE	
Micrathene whitneyi	Elf owl	SE	
Myiarchus tyrannulus	Brown-crested flycatcher	CSC	
Passerculus sandwichensis beldingi	Belding's savannah sparrow	SE	FSC
Pelecanus occidentialis californicus	California brown pelican	SE	FE
Phalacrocorax auritus	Double-crested cormorant	CSC	
Piranga flava	Hepatic tanager	CSC	
Piranga rubra	Summer tanager	CSC	
Polioptila californica californica	Coastal california gnatcatcher	CSC	FT
Progne subis	Purple martin	CSC	
Pyrocephalus rubinus	Vermilion flycatcher	CSC	
Rallus longirostris levipes	Light-footed clapper rail	SE	FE
Rallus longirostris yumamensis	Yuma clapper rail	ST	FE
Riparia riparia	Bank swallow	ST	
Rynchops niger	Black skimmer	CSC	
Sterna antillarum browni	California least tern	SE	FE
Toxostoma bendirei	Bendire's thrasher	CSC	
Toxostoma dorsale	Crissal thrasher	CSC	
Toxostoma lecontei	Le Conte's thrasher	CSC	
Vermivora virginiae	Virginia's warbler	CSC	
Vireo bellii arizonae	Arizona Bell's vireo	SE	

Table III-34 (cont.)
Sensitive Wildlife Species in the Southern California Region

Scientific Name	Common Name	Status State	Status Federal
Vireo bellii pusillus	Least Bell's vireo	SE	FE
Vireo vicinior	Gray vireo	CSC	
Antrozous pallidus	Pallid bat	CSC	
Dipodomys stephensi	Stephen's kangaroo rat	ST	FE
Euderma maculatum	Spotted bat	CSC	FSC
Eumops perotis californicus	California mastiff bat	CSC	FSC
Macrotus californicus	California leaf-nosed bat	CSC	FSC
Microtus californicus mohavensis	Mojave River vole	CSC	
Myotis velifer brevis	Cave myotis	CSC	FSC
Nyctinomops [=Tadarida] femorosaccus	Pocketed free-tailed bat	SC	
vis canadensis cremnobates	Peninsular bighorn sheep	ST	FPE
Perognathus alticola alticola	White-eared pocket mouse	CSC	FSC
Perognathus alticola inexpectatus	Tehachapi pocket mouse	CSC	FSC
Perognathus longimembris brevinasus	Los Angeles pocket mouse	CSC	FE
Perognathus longimembris pacificus	Pacific pocket mouse	CSC	FSC
Plecotus townsendii	Townsend's big-eared bat	CSC	
Sigmondon hispidus eremicus	Yuma cotton rat	CSC	FSC
Spermophilus mohavensis	Mojave ground squirrel	ST	FSC
Spermophilus tereticaudus chlorus	Palm Springs ground squirrel	CSC	FSC
Charina bottae umbratica	Southern rubber boa	ST	FSC
Clemmys marmorata pallida	Southwest pond turtle	CSC	FSC
Cnemidophorus hyperythrus	Orange-throated whiptail	CSC	FSC
Coleonyx switaki	Barefoot banded gecko	ST	FSC
Crotalus ruber ruber	Northern red-diamond rattlesnake	CSC	FSC
Eumeces skiltonianus interparietalis	Coronado skink	CSC	FSC
Xerobates agassizii	Desert tortoise	ST	FT
Heloderma suspectum	Gila monster	CSC	
Lampropeltis zonata pulchra	San Diego mountain kingsnake	CSC	FSC
Phrynosoma coronatum blainvillei	San Diego horned lizard	CSC	FSC
Phrynosoma coronatum frontale	California horned lizard	CSC	
Phrynosoma mcalli	Flat-tailed horned lizard	CSC	FPT
Salvadora hexalepis virgultea	Coast patch-nosed snake	CSC	
Uma inornata	Coachella Valley fringe-toed lizard	SE	FT
Batrachoseps aridus	Desert slender salamander	SE	FE
Bufo microscaphus californicus	Arroyo southwestern toad	CSC	FE
Ensatina eschscholtzi klauberi	Large-blotched slender salamander	CSC	FSC
Rana aurora draytonii	California red-legged frog	CSC	FT
Rana boylii	Foothill yellow-legged frog	CSC	FSC
Rana muscosa	Mountain yellow-legged frog	CSC	FSC
Scaphiopus hammondii	Western spadefoot	CSC	FSC

Table III-34 (cont.)
Sensitive Wildlife Species in the Southern California Region

Scientific Name	Common Name	Status: State	Status: Federal
Branchinecta lynchi	Vernal pool fairy shrimp		FT
Euphilotes battoides allyni	El Segundo blue butterfly		FE
Glaucopsyche lygdamus	Palos Verdes blue butterfly		FE
Rhaphiomidas terminatus	Delhi Sands flower-loving fly		FE
Streptocephalus woottoni	Riverside fairy shrimp		FE
Branchinecta sandiegonensis	San Diego fairy shrimp		FE

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FEDERAL: FE=endangered; FT=threatened; FPE=proposed endangered; FPT=proposed threatened; C=candidate for listing; FSC=species of concern.

Source: State Water Project Supplemental Water Purchase Program, Draft Program Environmental Impact Report (DWR, 1996)

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